WESTERN UNION TELEGRAPH COMPANY, JENNERSTOWN RELAY
(Western Union Telegraph Company, Laurel Hill Relay)
Laurel Summit Road off U.S. 30
Laughlintown vicinity
Westmoreland County
Pennsylvania

HAER PA-636
PA-636

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001

HISTORIC AMERICAN ENGINEERING RECORD

WESTERN UNION TELEGRAPH COMPANY, JENNERSTOWN RELAY (LAUREL HILL RELAY)

HAER No. PA-636

LOCATION:	Laughlintown Vicinity, Westmoreland County, Pennsylvania. USGS Ligonier, Pa. Quadrangle, UTM: 17.657754.4449391
DATE OF CONSTRUCTION:	1946
BUILDER:	Western Union Telegraph Company
PRESENT OWNER:	Mallet & Company, Inc. (Robert Mallet)
PRESENT USE:	Abandoned
SIGNIFICANCE:	The Jennerstown Relay was a part of the Western Union Telegraph Company's first commercial microwave telecommunications network known as the New York-Washington-Pittsburgh Radio Relay Triangle.
HISTORIAN:	David S. Rotenstein, Ph.D.
PROJECT INFORMATION:	The Jennerstown relay site was recorded by HAER in July 2005. HAER Architect Christopher H. Marston, HAER engineer-historian Dr. J. Lawrence Lee, HAER photographer Jet Lowe, and historian Dr. David S. Rotenstein conducted the fieldwork. Access to the Jennerstown site was graciously granted by property owner Robert Mallet. The Western Union microwave system is the subject of an independent research project by Dr. Rotenstein and he has conducted fieldwork at all of the sites in the network.

CHRONOLOGY

1794	Claude Chappe builds first "telegraph" network linking French cities Paris and Lille.
1830s	Samuel F.B. Morse and Alfred Vail begin experimentation in telegraphy.
1844	First electric telegraph message transmitted from Baltimore, Maryland, to Washington, D.C.
1899	Guglielmo Marconi transmits wireless signals in New York Harbor.
1906	Lee De Forest invents the Audion vacuum tube.
1927	The Federal Radio Commission (FRC) is created to regulate broadcasting in the United States.
1934	The Federal Communications Commission (FCC) is created and it absorbs the regulatory powers previously held by the Federal Radio Commission.
1939	The klystron tube is invented making microwave technology feasible.
1943	The Federal Communications Commission creates the Radio Technical Planning Board to study postwar radio.
1944	The Federal Communications Commission holds hearings (Docket 6651) to allocate spectrum for commercial microwave and other services.
1945	Western Union Telegraph Company in March receives FCC approval to build and operate an experimental microwave relay system; in October the company through its subsidiary the Telegraph Realty Co. acquires property for its Jennerstown relay station; experiments commence at relays between Philadelphia and New York City.
1947	The Telegraph Realty Company is liquidated and transfers title to the Jennerstown property and other Pennsylvania relay sites to the Western Union Telegraph Company.
1948	The Western Union Telegraph Company begins commercial operation of its first generation microwave network.
1976	Western Union sells the property, including the relay tower, to Mallet & Company.

HISTORICAL INFORMATION

Introduction

The Western Union Telegraph Company microwave relay system represents the first generation of postwar communications infrastructure that ushered in the information age or the "third industrial revolution."[1] Licensed by the Federal Communications Commission (FCC) and built by two communications industry pioneers – the Radio Corporation of America (RCA) and Western Union – the system laid the foundation for advances in telecommunications that began with wireless telegraphy, facsimile transmission, television, and telephony and ended with satellite communications and the Internet. The Jennerstown relay site was a node in the communications network Western Union dubbed the New York-Washington-Pittsburgh Radio Relay Triangle. The relay triangle was one of two networks Western Union built immediately after the FCC in 1945 allocated radio spectrum for microwave communications and both were among the first commercial microwave systems in the United States.

Jennerstown Relay

Through its Pennsylvania real estate subsidiary, the Telegraph Realty Company, Western Union acquired options on properties for microwave relay sites throughout the state. For its relay site in the Laurel Highlands of the Allegheny Mountains linking Pittsburgh with Washington, the company selected a parcel of farmland south of U.S. 30 between Laughlintown and Jennerstown, Pennsylvania. At the time the property was owned by Pittsburgh physician and educator Adolph Leo Lewin (1871-1953) who used the house he had built there as a summer residence.[2]

The Telegraph Realty Company paid Lewin $400.00 on 18 October 1945 for a 40,000-square-foot parcel plus a right-of-way for an access road and utility lines.[3] The tower and equipment building were completed in 1946 and the system went online in 1948. In 1947 Western Union liquidated and dissolved the Telegraph Realty Company in December 1947 and the subsidiary's

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[1] Louis Galambos, "Recasting the Organizational Synthesis: Structure and Process in the Twentieth and Twenty-First Centuries," *Business History Review* 79 (Spring 2005): 3, note 5; Richard N. Langlois, "The Capabilities of Industrial Capitalism," *Critical Review* 52, no. 4 (1992): 526.

[2] Lewin was a Prussian immigrant whose family had emigrated to the United State by way of England. He was educated in Pittsburgh and in Europe and began practicing medicine in Pittsburgh. In 1911 Lewin became a charter member of the Pittsburgh Board of Education; the property's current owner points out that tile in some of the house's bathrooms came from Pittsburgh schools: Robert Mallet, Personal Communication, Interview at Jennerstown Relay Site (23 October 2004); "Adolph Leo Lewin," in *The National Cyclopaedia of American Biography, Being the History of the United States*, vol. XLII (Ann Arbor, Michigan: University Microfilms, 1967), 409-10; Board of Public Education, *A Study of the Educational Development of the Pittsburgh Public Schools* (Pittsburgh, Pennsylvania: The Board of Public Education, 06/03/17 1928), 23.

[3] Westmoreland County Deed Book 1225, p. 588; Somerset County Deed Book 347, p. 49. Lewin's property spanned the Westmoreland and Somerset county lines and the access road terminates in Somerset County. Instruments, therefore, were recorded in both counties.

assets, including the Jennerstown relay site were transferred to the Western Union Telegraph Company.[4]

The Jennerstown relay site was also known as the "Laurel Hill Relay." It was the intermediate station between the Little Savage relay in Garrett County, Maryland, 35.2 miles to the southeast and the Fort Hill relay in Pittsburgh, 49.3 miles to the northwest. Jennerstown operated on Western Union's RB5 system and was rated for telegraphy, telephony, facsimile, and composite transmissions. Maintainer notations made on radio equipment inside the building indicate that the units were last checked in February 1963. These dates may correspond to the period that Western Union abandoned the site.

Western Union sold the property for $650.00 on 31 March 1976 to Mallet and Company.[5] Robert Mallet raises horses on the farm he uses as a weekend retreat. In July 1977 the Crown Construction Company mounted an antenna on the former Western Union tower to facilitate communications during the recovery from flooding that struck the Johnstown, Pennsylvania, region.[6]

DESCRIPTION

The Jennerstown Relay is located on Pea Vine Hill, a knob on Laurel Hill in the Laurel Highlands portion of the Allegheny Mountains. Pea Vine Hill peaks at 2,900 feet above sea level and the relay station is located at this elevation. The relay site is accessed by a 0.8 mile long unsurfaced road connecting to Laurel Summit Road south of its terminus at U.S. 30. A commercial power line enters the site from the east. The relay site is situated in a clearing surrounded by mixed hardwood forest.

Compound

The relay station is enclosed within a metal chain-link fenced compound. The fence (Cyclone Fence Company) is topped by three strands of barbed wire. There are gates in the north and west sides and the compound has a gravel surface.

Equipment Building

This one-story rectangular building measures 15′ x 30′-8″ and is constructed on a concrete slab foundation. Built of concrete blocks, the building's fenestration is functional and minimal,

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[4] The Telegraph Realty Company transferred the Jennerstown assets on 29 December 1947. Somerset County Deed Book 375, p. 430.

[5] Westmoreland County Deed Book 2209, p. 911.

[6] Mallet, Personal Communication.

designed to protect the relay station's radio equipment from the elements and from unauthorized access. There is an entrance in the building's north façade and there is one window in its east façade. Vents with metal hoods pierce the building's west and south facades. The front entrance has a rectangular poured concrete slab porch. The building's main entrance has a solid-core, metal clad two-panel door that is secured by a deadbolt lock and two padlocks. The window in the east wall is a wood double-hung sash (1/1 lights) unit and it is concealed behind a pair of exterior hinged metal shutters secured on the interior by a pair of metal bars. A two-panel wood door located in the south façade leads to the heater room and is secured by a single deadbolt lock. The ventilation hoods in the south and west walls are metal alloy and conceal louvered vents protected by wire mesh (0.5") attached to the hood interior. A third louvered vent is located above the door in the south façade and this ventilates the heater room. An off center concrete block chimney with a hollow clay tile liner pierces the built-up shed roof from the heater room. There is a metal gutter that runs the length of the south wall at the roof line. At some point a gutter had been attached to the southwest corner of the building and it drained into a poured concrete spillway that empties into the tower compound interior.

A key element of the equipment building's physical plant is an underground fuel storage tank located adjacent to the building's south wall. Its location is marked by a concrete cone encasing the intake pipe and a metal sign mounted on the building's south façade that reads "GAS." The intake is sealed by a threaded metal cap marked "Fuel Oil / 204-35-SA" and "R.I. Fittings Co. / Hillsgrove, R.I." Western Union intended each of its relay sites to have a 120-gallon storage tank to provide for as much as six days of continuous operation. The capacity was limited to reduce the potential for "gum formation."[7] The fuel entered the equipment building through a buried pipe and was measured by a gauge mounted inside the engine room.

Radio Room

The radio room is the first space entered once inside the equipment building. It is a rectangular open space with a single metal cabinet housing the facility's radio equipment. The radio cabinet is located in the eastern end and it is a vertical unit connected to the room's south wall by two metal braces; it also is connected to a power source and tower relay equipment via metal conduits attached to the cabinet's top. These conduits are suspended from the ceiling by metal straps. There is a metal heating duct that follows the southern ceiling/wall. Electrical fixtures in the equipment room include a single electric bulb socket in the ceiling, electrical outlets attached to the north and south walls, and a light switch (to control lighting in the radio room, battery room, and heater room) on the north wall. There is a pair of thermostat controls for the heating system on the south wall, both manufactured by the Minneapolis-Honeywell Regulator Company. The eastern (left) side thermostat controlled the radio room – it is labeled in pencil, "Room Temp Control" – and the west (right) unit is marked in pencil "Frigistat" on its cover (this unit also is marked "40°" and "Reads 2° Low").

[7] H.M. Ward, "Power Supplies for Microwave Relay Systems," *Western Union Technical Review* 3, no. 4 (October 1949): 136-37.

Table 1

Jennerstown Relay Station Radio Station Rack

West to East		East to West
MI-31540 Transmitter control unit. Monitors associated transmitter; repeats incoming service channel modulations; provides modulating signal for fault control unit; contains a portion of the AFC circuit.		**MI-31540** Transmitter control unit. Monitors associated transmitter; repeats incoming service channel modulations; provides modulating signal for fault control unit; contains a portion of the AFC circuit.
MI-31401 Receiver control unit 1. Monitors an associated receiver and adjusts its frequency.		**MI-31401** Receiver control unit 1. Monitors an associated receiver and adjusts its frequency.
MI-31521 Unit marked: WU TEL CO. AMPLIFIER MOUNTING PANEL 7446-A. Triple IF amplifier for main receiver and diversity signals.		**MI-31521** Triple IF amplifier for main receiver and diversity signals.
MI-31401 Receiver control unit 2.		**MI-31401** Receiver control unit 2.
MI-31521 Unit marked: WU TEL CO. 160V DC POWER SUPPLY // THE DAVEN CO. NEWARK, NJ 7448-A		Not present at Jennerstown.
MI-31542 DC power supply.		**MI-31542** DC power supply.
MI-31541B Fault locating unit. Modulates signal from the transmitter control and notifies other relays in the event of a loss of AC power.		**MI-31552-2** Blank panel.
MI-31546 Power termination panel.		**MI-31547** Cable termination panel.
Information derived from the RCA Microwave Relay Equipment manual, pp. 13-34 and equipment noted in this chart corresponds to the front (north) of the cabinet. The **bold** text represents original RCA part numbers.		

The radio equipment is housed in a vertical rectangular metal double-cabinet approximately 7'-1" high with two 1'- 7 3/16"-high racks. The cabinet originally was designed as a four-door unit (two in front, two in back), but only the pair of rear doors remains. Each rack was designed to mount transmission, reception, and power supply units associated with west-east or east-west traffic. The panel controls (meters, switches, etc.) and tubes are broken, heavily oxidized, or removed on some of the units; others, like the MI-31521 amplifier in the west-east rack (left) are intact with minor damage. The 7446-A amplifier unit is notable in the left rack because it has maintainer notations in black magic marker on its face. The notes read “Tubes checked 2/13/63,”

suggesting the unit's last inspection while in service was in the winter of 1963.

Battery Room

Located in the southern portion of the building, the battery room is entered from the radio room through a solid metal door. The rectangular room has three wood shelves (paired beams) mounted on the southern wall by metal bars anchored in the concrete block. The shelves held a bank of fifty-seven batteries connected to the station's vibrator unit (power supply, e.g., an inverter to transform direct current into alternating current, located in the engine room).[8] There are 45-amp fuses attached to each shelf; these in turn are connected by wire conduits to a stamped steel switch box mounted on the battery room's west wall. The 60a/250V single throw switch box was manufactured by the Square D Electrical Company (Catalog number 84252, Series no. 3).

Engine Room

This rectangular room is located in the western portion of the building and it is entered from the radio room through a solid metal door. A raised rectangular concrete foundation (5'-0" x 2'-0") for a four-cylinder gasoline engine occupies the center of the floor. The fuel pipe that enters from the foundation on the west side of the concrete platform is sheared off. Machinery in the room includes electricity regulating equipment and motors to operate louvers in vents that pierce the south and east walls. The vent in the west wall was intended to carry air heated by the engine's radiator out of the building. When in operation, the engine was connected to this vent by a canvas duct.[9] The vent in the south wall allowed fresh air to enter the room. Both vents had electric motors attached to linkages that opened the louvers while the engine was running. Engine exhaust exited through a pipe in the building's south wall.

On the west wall were mounted the fuel level gauge ("Midget Levelometer" manufactured by the Liquidomter Company of Long Island City, New York), fuse box, and master disconnect switch. The 10-circuit fuse box was manufactured by the Trumbull Electric Company of Plainville, Connecticut. The fuse box included circuits for the equipment building and tower lights.

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[8] Ward, "Power Supplies for Microwave Relay Systems," 137.

[9] Ward, "Power Supplies for Microwave Relay Systems," 136.

Table 2 Jennerstown Relay Station: Engine Room Fuse Box Circuit Assignments	
Circ. No.	
1	3 Light RCA Room, 1 Light Battery Room, 1 Light Engine Room
2	1 " ", 1 " ", 2 " "
3	1 Receptacle Battery Room, 1 Receptacle Engine Room, Oil Burner
4	2 Receptacle RCA Room, 1 " "
5	Tower Lights
6	Rectifier Cabinet
7	Spare
8	Panel Feed in Cab
9	Spare
10	Spare

The vibrator unit (inverter) cabinet still stands next to the room's north wall. Conduits connected it and the generator to an overhead cable duct leading to the radio room. Inside the cabinet was a single-phase "constant voltage transformer" manufactured by the Sola Electric Company of Chicago, Illinois. The unit also was connected to a General Electric "voltage stabilizer" mounted on the north wall.

Heater Room

The heater is located in a square room entered from the building's south side. The oil-burning heater was installed in the east side of the room. It was manufactured by the Viking Manufacturing Company of Dayton, Ohio. The unit included a power supply and circulator. Exhaust was vented through a flue leading to the building's chimney and warm air was sent into the building's interior by way of metal ducts suspended from the ceilings. The heater was controlled by a "combination fan and limit control" box mounted on the flue. The concrete block chimney is located in the room's southeast corner and there is a cleanout box near the room's floor.

Although Western Union relay stations were unmanned, the heating units were required to prevent condensation from forming in the building's equipment and to ensure that the inside temperature remained above forty degrees Fahrenheit to maintain battery capacity "at excessively low temperatures."[10] Maintainer notations in pencil on the room's west wall appear to date between 1950 and 1956 and indicate dates (e.g., 9/28/50), fuel amounts (e.g., "220 gals."), and heater states ("on" or "off").

[10] Ward, "Power Supplies for Microwave Relay Systems," 135.

Tower and Cab

The relay station's tower, which includes its structure, cab, catwalks, stairs, certain electronic components, and conduits, is the facility's most prominent feature. The self-supporting lattice tower is constructed of rolled, L-section members furnished by the Bethlehem Steel Company. The square-plan structure has eight panels and rises 100', not including the cab. Each of the tower's four legs rests on a concrete footing with beveled top edges, and each leg is secured to it by anchor bolts, washers, and dual hex nuts (the second ones are lock nuts). Each leg is electrically grounded with copper wires. Most of the horizontal and diagonal members were doubled to form the equivalents of T or cruciform sections, while a single, heavier L section sufficed for each leg. Using a proven Aermotor design to enable easy construction at the site, the tower's legs, girts, and braces were bolted together using square-head bolts and hex nuts (with bolt heads generally facing out or down). Stamped metal "Palnuts," manufactured by the Tinnerman Company, serve as locknuts. Some assemblies include washers, and gussets stiffen all major connections. All structural members, fasteners, and gussets were galvanized for corrosion resistance. This tower shows no evidence of ever having been painted orange and white for enhanced visibility from aircraft. Approximately 34,000 pounds of steel were used in the Jennerstown Tower.

Access to the cab atop the tower is through a steel interior stairway anchored by a poured concrete step. The stairway – stringers formed from pairs of L-struts connected by Warren truss webbing, open mesh treads, and L-post rails – rises seven flights to a final flight located on the tower exterior that leads to the catwalk and equipment cab at the tower's crown. Each landing is located in alternating corners of the tower.

The tower carries conduits for radio cables (interior) and power supply (exterior). The conduit leaves the equipment building through its south wall (southeast corner) and it is carried to the tower in a steel enclosed cable trough (also called an "ice bridge") mounted to the tower by struts and guy wires. The conduit becomes vertical inside the tower and the power supply splits and is carried into the tower by a pipe conduit while the radio cables remain inside the square steel conduit. The steel conduit has junction boxes with access panels situated between landings.

Radio equipment is located in two places on the tower: in the cab and on the sixth landing. The equipment on the sixth landing consists of radio cabinets and antenna mounts located on the south and south sides of the tower. These accommodated units described in Western Union technical literature as "diversity receivers." These receivers were added to the original engineering design to stabilize reception. The remaining equipment on the west side is an RCA MI-31400 receiver mounted inside a temperature-controlled container that contains an internal heater and external vent mounted on the unit's exterior. The receiver's front panel is attached to its case by hinges and its dials and controls are missing. The manufacturer's name and model markings are visible. The heating element, a General Electric "strip heater," was attached to the housing and its compartment retained its insulation. The radio equipment on the west side of the landing had been removed and only the heater and housing remain in place.

The square-plan cab at the top of the tower has a wood floor and is surrounded on all sides by a

metal catwalk and metal pipe rail. It is reached by an exterior stairway leading from the seventh landing to the catwalk. The cab is accessed by a door in its north façade. The upper platform is 20'-4" x 18'-8.5" and the cab is 12'-0" x 12'-0". Mounted to the cab's west façade is a parabolic antenna with a 3'-0" diameter and a waveguide connecting it to the cab interior through a piercing in the west wall. The cab is clad with corrugated galvanized steel and it has a pyramidal galvanized steel roof. There is a single casement window, three-lights per frame, in the south wall and rectangular piercings in the west and south walls are covered by radio-frequency transparent fiberglass panels. The panels are perforated for ventilation; the panel in the south wall is marked with the station name. Power junction cabinets and cable conduits are attached to the interior of the north wall, east of the door.

There are four bolted steel L-beams placed diagonally inside the cab at approximately 10' above the floor. These beams served as supports for the vertical antenna and radio equipment box (head-end units) mounting racks. The antennas, which would have been mounted side by side on the racks facing the RF-transparent panels, are missing, however the mounting brackets remain connected to the racks. The head-end units cases, paired in each rack – transmitters and receivers for each direction, i.e., towards Washington and towards Pittsburgh – are intact but all of the radio equipment has been removed. Each unit was hinged to open downward and the face of each was marked with the system identified, "RB 5", along with the appropriate label, "RECV" for receivers and "TRANS" for transmitters. The racks are consistent with RCA equipment manuals published for Western Union and are illustrated in Western Union technical and promotional literature.

THE WESTERN UNION MICROWAVE SYSTEM

Four urban terminals and twenty-one rural relay sites with towers ranging from 60' to 120' high comprised Western Union's first generation microwave system in two segments: an experimental link between New York and Philadelphia and the company's first regional system dubbed the "New York-Washington-Pittsburgh Radio Relay Triangle." The network was a complex compound artifact: each relay was a node in the network with the radio links providing the connective tissue to enable transactions between distant terminals. Discretely, each site is an ordinary isolated steel tower and concrete block building inside a cyclone fence enclosure. Change the resolution from the site to the region and the interconnections that transform electrical signals into information become the focal point. Zoom out even farther to the social and economic contexts in which the network developed and Western Union's microwave network becomes an artifact of technological change enabled and regulated by the state. Western Union's network went online communicating telegrams, facsimiles, and telexes before the better known AT&T microwave network making it a key milestone in American technological history. The infrastructure footprint Western Union's network created became not only a significant landmark in the third industrial revolution but it also marked the inception of an intensive period of wireless telecommunications infrastructure development that created a landscape of antenna farms rising from mountaintops across the continent.

Although the literature of telecommunications technology and regulation is voluminous, there

are few thematic and site-specific studies of the material culture of telecommunications infrastructure. Exceptions to this include archaeological testing of nineteenth century Dutch optical telegraph sites on Curaçao in the Netherlands Antilles and HAER documentation of Cold War-era White Alice stations in Alaska and California's Chollas Heights Naval Radio Transmitting Facility.[11] Studies in Europe include English Heritage's survey of six Cold War-era microwave sites which resulted in the designation of London's BT Tower as a protected national monument.[12]

The economic, social, and technological changes that accompanied the large-scale transformation of energy into consumer products, workshops into factories, and yeomen into wage laborers joined with individual entrepreneurship to define the first industrial revolution in the years bracketing the turn of the nineteenth century. During the mid-to-late nineteenth century corporate entrepreneurship and managerial hierarchies prevailed in the market. They combined with a communications infrastructure anchored by railroads and telegraph companies, expanded workforces, and the economy as distance was eliminated as a significant barrier to production and trade. These events frame the boundaries of the second industrial revolution. In the aftermath of the Second World War government regulatory agencies wielded a firm visible hand over innovations in telecommunications, aviation, and electronics to mark the 1940s and 1950s as the opening years of the third industrial revolution that we know as the information age.[13]

Infrastructure is a common thread linking many of the technological and economic transformations we associate with the events generally described as the "industrial revolution." Industrialization embraces increased efficiency, reduced transaction costs, and greater outputs. Telecommunications is one of four infrastructure modes that form the foundation of modern society, the others being transportation, energy utilities, and money.[14] Economic success in telecommunications depends upon achieving an economy of scale – this means that high fixed costs or capital investment and low variable costs result in reducing the time and transaction

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[11] Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, "Chollas Heights Naval Radio Transmitting Facility," HAER No. CA-154; Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, "Rabbit Creek White Alice Site," HAER No. AK-23; Jay Haviser, "Archaeological Testing at Optical Telegraph Sites on Curacao," in *Proceedings of a Symposium on the Optical Telegraph Held in Stockholm, June 21-23, 1994* (Stockholm, Sweden: Telemuseum Press, 1994), 25-31; Jay Haviser, "Archaeological Investigation at Optical Telegraph Sites on Curacao" (Willemstad, Curacao, Netherlands Antilles: Archaeological-Anthropological Institute of the Netherlands Antilles, 1994), Report on file, National Museum of Science and Technology, Stockholm, Sweden.

[12] Wayne D. Cocroft, *Cold War Monuments: An Assessment by the Monuments Protection Porgramme* (London, England: English Heritage, 2001); Wayne D. Cocroft and Roger J. C. Thomas, *Cold War: Building for Nuclear Confrontation 1946-1989* (London, England: English Heritage, 2003), 218-24.

[13] Galambos, "Recasting the Organizational Synthesis," 3; Louis Galambos and Eric John Abrahamson, *Anytime, Anywhere: Entrepreneurship and the Creation of a Wireless World* (Cambridge: Cambridge University Press, 2002), 254-55; Langlois, "The Capabilities of Industrial Capitalism," 526.

[14] Britt Horwitz, *The Irony of Regulatory Reform* (New York, New York: Oxford University Press, 1989), 11-12.

costs between transmission and reception.[15] Wired, point-to-point communications require technology for transmission and reception, rights-of-way, poles, cable, and labor to ensure and maintain connectivity. Telegraphy, telephony, broadcasting, computers, and the present search for the ultimate wireless grail are industrialization's quintessential material culture. Dutch engineer Anton Huurdeman underscored the significance of telecommunications infrastructure in writing, "In the nineteenth century, high chimneys in the landscape were appreciated as symbols of industrial progress. Similarly, in the twentieth century, telecommunications towers became the visible signs of the information society."[16]

Few records survive documenting Western Union's activities (maintenance, equipment upgrades, etc.) at the Jennerstown relay site.[17] The facility's history is best understood when viewed in its context in relation to the other Western Union microwave sites and the technological and governmental regulatory changes that occurred during the Second World War that made possible the commercial use of microwave communications technology.

Telecommunications History

The electromagnetic spectrum is unlike coal, iron ore, trees, and water: it is a natural resource that cannot be mined, packed, diverted, or shipped by rail. Its ecological relationship to culture is directly related to the technological sophistication of the people trying to make use of it.[18] Spectrum is divided into regions by measuring the characteristics of its transmission, i.e., the number of cycles per second (frequency) of electromagnetic current. Small portions of it are visible while others are only accessible and measurable by electronics. The visible portion – light – occupies the part of the spectrum between infrared and ultraviolet light whereas sound (e.g., vibrations) that had been converted into radiation can only be detected by electronic means. The portion of spectrum known as the radio spectrum occupies the range between 3KHz and 300 GHz. The technologies making the radio spectrum commercially viable have been in use since the last quarter of the nineteenth century. Although inventor Guglielmo Marconi (1874-1937) is popularly credited with "inventing" wireless communications, his work – like that of Alexander Graham Bell and Thomas Alva Edison – broke beyond the technical milestones of other inventors to become accessible to the wider public and profitably reproducible by industry.[19]

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[15] Ithiel de Sola Pool, *Technologies Without Boundaries: On Telecommunications in a Global Age* (Cambridge, Massachusetts: Harvard University Press, 1990).

[16] A. Huurdeman, *The Worldwide History of Telecommunications* (New York, New York: J. Wiley, 2003), 393.

[17] Property owner Robert Mallet believes that he once had a Western Union maintainer's log book but he was unable to locate it.

[18] W. Hazlett, "The Wireless Craze, the Unlimited Bandwidth Myth, the Spectrum Auction Faux Pas, & the Punchline to Ronald Coase's "Big Joke": An Essay on Airwave Allocation Policy," *Harvard Journal of Law and Technology* 1443, no. 2 (Spring 2001): 335-469; David E. Nye, "Shaping Communication Networks: Telegraph, Telephone, Computer," *Social Research* 64, no. 36 (Fall 1997): 1067-91; Pool, *Technologies Without Boundaries.*

[19] J. Douglas, *Inventing American Broadcasting: 1899-1922* (Baltimore, Maryland: The Johns Hopkins University Press, 1987).

In the years following Marconi's 1899 wireless reporting of the America's Cup races in New York Harbor, amateurs, the government, and shipping companies rapidly entered the wireless realm. Experiments in receiver and transmitter technology as well as content, including voice and pictures, spurred an accelerated rate of culture change in the United States. Key technical milestones during the first few decades of wireless telecommunications include the ability to transmit and receive voice and music signals (Reginald Fessenden and the continuous wave alternator) and the capability to detect and amplify, i.e., tune to, a specific frequency (Lee DeForest and the Audion vacuum tube). Wireless offered the public a release from corporate monopoly in telephony and telegraphy while simultaneously creating a need for government oversight to police the use of spectrum and ensure its use did not interfere with maritime safety and national defense.

Barriers to entry into wireless telecommunications were erected by the federal government with the passage of the Radio Act of 1912, the Radio Act of 1927, and the Communications Act of 1934.[20] The latter created the Federal Communications Commission and combined the regulation of telephony and telegraphy with broadcasting; these laws purportedly sought to prevent interference and protect American values by treating spectrum as a scarce publicly-owned resource.

The architectural and engineering template for microwave relay sites is derived from early optical or visual communications facilities. Telecommunication involves the sending and receiving of "signs, signals, writing, images, sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems."[21] The transmission of signals across land and water to expedite the exchange of information between and among people has its roots in antiquity with early optical signaling systems that included flags, smoke signals, and mirrors (heliographs).[22] Precursors to modern telecommunications infrastructure include first century A.D. Roman guardhouses from which torches signaled distant approaching threats to French inventor Claude Chappe's 1794 semaphore network between Paris and Lille. Inventors feverishly conducted experiments in electromagnetic telegraphy during the first half of the nineteenth century.

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[20] G. Caldwell, "The Standard of Public Interest, Convenience or Necessity as Used in the Radio Act of 1927," *Air Law Review* 1, no. 3 (July 1930): 295-330; Ronald H. Coase, "The Federal Communications Commission," *Journal of Law and Economics* 2 (1959): 1-40; Hugh Slotten, *Radio and Television Regulation: Broadcast Technology in the United States, 1920-1960* (Baltimore, Maryland: Johns Hopkins University Press, 2000); Robert Carleton Smith, "Legal Phases of Radio Communication," *Journal of Business of the University of Chicago* 2, no. 3 (July 1929): 291-311.

[21] Federal Communications Commission, *A Glossary of Telecommunications Terms* (Washington, D.C.: Federal Communications Commission, 1998), 35.

[22] W. Burns, *Communications: An International History of the Formative Years* (London, England: Institution of Electrical Engineers, 2004), 1-28; Gerard J. Holzmann and Björn Pehrson, *The Early History of Data Networks* (Los Alamitos, California: IEEE Computer Society Press, 1995), 1-46; George P. Oslin, *The Story of Telecommunications* (Macon, Georgia: Mercer University Press, 1992), 1-12; Tal P. Shaffner, *The Telegraph Manual: A Complete History and Description of the Semaphoric, Electric and Magnetic Telegraphs of Europe, Asia, Africa, and America* (New York, New York: Pudney & Russell, Publishers, 1859), 2-26.

The Western Union Telegraph Company was incorporated in 1856, twelve years after Samuel F.B. Morse (1791-1872) and his collaborator, Alfred Vail (1807-1859) demonstrated an electromagnetic telegraphy system 24 May 1844 complete with transmission and reception technology and a software system – Morse code – using a Baltimore to Washington telegraph line.[23] Formed by the consolidation of several smaller telegraph companies using electrical telegraphy as the means for long distance communications, the company expanded in concert with railroads to create the first national telecommunications network.[24] For two decades Western Union had a natural monopoly and then in 1876 Bell perfected and patented the telephone. Patent litigation and competition united Bell and Western Union in an uneasy telecommunications oligopoly lasting nearly a century.[25]

The path to wireless telegraphy and telephony was opened by Marconi's entrepreneurial and technological successes. Marconi's 1899 arrival in the United States spurred the first of four periods of intensive telecommunications infrastructure development and concomitant regulatory regimes. The first period, from c. 1900 to 1917, saw the appearance of coastal commercial and military wireless facilities and the proliferation of amateur antennas across the nation. Commercial broadcasting's birth in 1920 spurred the rapid construction of radio stations up to the start of the Depression in 1929 comprising the second period of infrastructure development. The third period beginning in 1945 was facilitated by landmark spectrum allocation hearings held by the FCC the year before that resulted in major allocations and frequency assignments to industry. Finally, the fourth period may be linked to the Telecommunications Act of 1996 and the intensification of cellular and PCS facilities siting.

In the United States technological advances in telecommunications were inextricably tied to governmental regulation. The United States began regulating wireless communications in 1910 with the passage of the Wireless Ship Act. Enacted in the wake of a 1909 shipping accident, the law was aimed at ensuring spectrum access in maritime emergencies.[26] In the spring of 1912 the ocean liner *Titanic* sank and significant flaws in the 1910 act were exposed. With radio a little more than a decade old, there were several hundred thousand amateur operators plus commercial and navy stations. Interference was rampant and fake distress calls were clogging the ether. Failures to detect and respond to the Titanic's distress calls spurred Congress to pass the Radio Act of 1912.[27] The Radio Act of 1912 put the Department of Commerce in charge of regulating

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[23] Burns, *Communications*, 80-86; Oslin, *The Story of Telecommunications.*

[24] D. Chandler Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge: Harvard University Press, 1977), 195-203; Daniel D. Czitrom, *Media and the American Mind: From Morse to McLuhan* (Chapel Hill: University of North Carolina Press, 1982), 3-29.

[25] John Brooks, *Telephone The First Hundred Years: The Wondrous Invention That Changed a World and Spawned a Corporate Giant* (New York, New York: Harper & Row Pulbishers, 1976); Claude S. Fischer, *America Calling: A Social History of the Telephone to 1940* (Berkeley, California: University of California Press, 1992); David Hochfelder, "Constructing an Industrial Divide: Western Union, AT&T, and the Federal Government, 1876-1971," *Business History Review* 76 (Winter 2002): 705-32.

[26] Slotten, *Radio and Television Regulation*, 6-7; Smith, "Legal Phases of Radio Communication," 295.

[27] Hugh G.J. Aitken, "Allocating the Spectrum: The Origins of Radio Regulation," *Technology and Culture* 35, no. 4

wireless communications, and it authorized the department to issue broadcast licenses.

Congress in 1934 created the Federal Communications Commission (FCC) to succeed the seven-year-old Federal Radio Commission (FRC), the nation's first regulatory agency charged with oversight of the airwaves. The Communications Act of 1934 required the creation of the FCC to regulate "interstate and foreign commerce in communication by wire and radio."[28] Basically, Congress expanded the regulatory regimen established under the Radio Act of 1927 law combining regulation of the nascent broadcast industry with the established telephone and telegraph sectors into a single federal agency.[29] Key FCC responsibilities were the management of the radio spectrum through allocation and allotment and assigning licenses to use the spectrum.[30] The FCC also was responsible for setting the technical standards for transmitters and receivers used in the various sectors of the communications industry to ensure compatibility and prevent interference from emissions within the radio spectrum.[31] The FCC's mandate bonded communications technology to federal regulatory oversight.

In addition to controlling spectrum and equipment standards, the FCC also was responsible for regulating broadcast tower sites in coordination with the Aeronautics Branch of the Department of Commerce (precursor to the Bureau of Air Commerce and the later Federal Aviation Administration). Radio and commercial and private aviation came of age at the same time and broadcasting's infrastructure – towers – were potential "obstructions to air navigation."[32] The 1930s brought the first federal tower painting and lighting requirements. The earliest tower marking schemes included beacon lights and alternating painted tower segments: either alternate bands of chrome yellow and black or alternate bands of white and black.[33] In 1936 new marking standards were recommended and these were adopted in the summer of 1937. The new standards included painting certain towers in alternating bands of "international orange" and white, the standard that persists into the twenty-first century.[34] Towers were to be lighted based on height

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(October 1994): 690-91; Slotten, *Radio and Television Regulation*, 7-8.

[28] P.L. 416-73rd Congress, Title I, §1.

[29] Coase, "The Federal Communications Commission."

[30] Coase, "The Federal Communications Commission"; Gregory L. Rosston, "An Economic Analysis of the Effects of FCC Regulation on Land Mobile Radio" (Ph. D. diss., Stanford University, 1994), 8.

[31] Slotten, "Rainbow in the Sky: FM Radio, Technical Superiority, and Regulatory Decision-Making," *Technology and Culture* 37, no. 4 (October 1996): 686-720; Slotten, *Radio and Television Regulation*, 68-112.

[32] United States Department of Commerce, Aeronautics Branch, National Archives and Records Administration, Records of the Federal Communications Commission. Record Group 173, Box 477, 1 August, 1930, File: 130-3, "Regulations Governing Establishment and Certification of Aeronautical Lights and Instructions for Marking Obstructions to Air Navigation," Washington, D.C., Government Printing Office.

[33] United States Department of Commerce, Aeronautics Branch, RG 173, "Marking Obstructions to Air Navigation."

[34] D. Fagg, National Archives and Records Administration, Records of the Federal Communications Commission. Record Group 173, Box 477, 1 June, 1937, File: 130-3, Letter to the Secretary of the Federal Communications

and proximity to aeronautical facilities (i.e., airports, landing areas, or designated landing approaches). For example, towers 200' or higher above the ground were required to be lighted and painted while lower towers were to be marked at the discretion of the FCC and Bureau of Air Commerce. The government wanted to ensure all broadcasters got the message and embarked on a public relations campaign that included sending color chips illustrating the "international orange" standard to newspapers throughout the United States.[35] The campaign worked. On 14 September 1937 *The Washington Post* carried this headline: "Attire of Orange and White Ordered for Radio Antennae."[36]

Besides solidifying the regulatory framework for the American communications industry, the 1930s were a significant period in technological advances. Engineer Edwin Armstrong (1890-1954) in 1933 invented frequency modulation (FM) radio as a static-free alternative to amplitude modulation (AM) radio. FM radio differed from AM by the way broadcast signals were encoded and transmitted. By effecting changes in a radio wave's frequency (measured in cycles per second), broadcasters could reduce signal fading and interference that results in static caused by natural phenomena and other transmitters.[37]

While Armstrong was experimenting to develop FM, engineers were working on developing other ways to use the radio spectrum. In Europe French engineers successfully tested the first microwave communications technology in 1931. Three years later a microwave network linking aerodromes in Calais, France, and Lympne on the English coast provided telephone and teleprinter communications.[38] Microwaves are super high frequency radio waves used in radio for point-to-point communications and the microwave spectrum is located at the higher end of the radio spectrum in the 1 GHz (gigahertz or billion cycles per second) range. Higher frequencies allowed for directional beam technology that did not require large and expensive antennas because microwaves travel in straight lines. This technology was found to be useful in detecting obstacles by bouncing high frequency waves off objects via parabolic reflector antennas. The new radar technology initially was deployed to detect icebergs at sea and was adapted to military use during the Second World War.[39]

Commission, Washington, D.C., Department of Commerce; United States Federal Communications Commission, National Archives and Records Administration, Records of the Federal Communications Commission. Record Group 173, Box 477, 18 August, 1937, File: 130-3, Press Release. Subject: Antenna Tower Marking, Washington, D.C., Federal Communications Commission.

[35] R.S. Boutelle, National Archives and Records Administration, Records of the Federal Communications Commission. Record Group 173, Box 477, 10 July 1937, File: 130-3, Letter to the Secretary of the Federal Communications Commission, Washington, D.C.

[36] United Press, "Attire of Orange and White Ordered for Radio Antennae," *The Washington Post*, 14 September 1937, 11.

[37] Slotten, *Radio and Television Regulation*.

[38] Burns, *Communications*, 577.

[39] Burns, *Communications*, 577-84.

The Second World War stimulated experimentation in radio technology, especially in the development of radio tubes and in propagation.[40] "Experimentation and development have occurred in almost every field of radio including television, facsimile, frequency modulation, direction-finding, and selective calling devices," the FCC reported in its Annual Report for 1942.[41] Many of the advances made in the 1930s – television and FM radio among them – were put on hold during the war and their commercial use was delayed.

Planning for the postwar period began in 1943 with the formation of the Radio Technical Planning Board (RTPB). In November 1942 FCC chairman James Lawrence Fly delivered a speech before a joint meeting of the Radio Manufacturer's Association and the Institute of Radio Engineers in which he suggested the establishment of an industry body to explore "frequency allocations and system standards" based on technological developments made during the Second World War.[42] The communications industry followed up Fly's suggestion in early 1943 by developing a plan to establish a group they called the Radio Technical Planning Board. Composed of representatives drawn widely from broadcasting and equipment manufacturers spanning the breadth of the communications industry, the new board was divided into thirteen topical panels. The panels ran from the general, like Panel 1 (Spectrum Utilization) to the specific like Panels 6 and 7, Television and Facsimile, respectively. The companies represented included RCA, Philco, Bell Telephone Labs, Westinghouse, and Western Union. General Electric vice president William R.G. Baker (1892-1960) was selected to chair the new board and individual panel chairmen were selected in October 1943.

Relay Systems was the topic assigned to Panel 9, chaired by RCA engineer E.W. Engstrom. Meeting for the first time in the Hotel Pennsylvania in New York City 15 February 1944, the panel defined its scope and divvied up responsibilities among its nineteen members. The panel proposed to evaluate "all types of relay systems involving one or more intermediate radio repeater stations."[43] In the subsequent allocation hearings filed under FCC Docket number 6651 and held in the fall of 1944, the FCC adopted the definition set by Panel 9 and limited it to "common carrier systems" and a few select "private radio services excluding "police, forestry" and other services covered in separate panels in the FCC hearings.[44] During the spectrum

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[40] Slotten, *Radio and Television Regulation*, 154-55.

[41] Federal Communications Commission, *Federal Communications Commission Twelfth Annual Report. Fiscal Year Ended June 30, 1942* (Washington, D.C.: Federal Communications Commission, 1942).

[42] W.R.G. Baker, National Archives and Records Administration, Records of the Federal Communications Commission. Record Group 173, Box 3, Records of the Radio Technical Planning Board Meetings, 1942-1948, 27 September, 1944, File: Statement of Operations of the Radio Technical Planning Board, Summary of Operations of the Radio Technical Planning Board.

[43] Radio Technical Planning Board, National Archives and Records Administration, Records of the Federal Communications Commission. Record Group 173, Box 3, Records of the Radio Technical Planning Board Meetings, 1942-1948, 27 September, 1944, Minutes of First Meeting Panel 9 - Relay Systems Radio Technical Planning Board, Hotel Pennsylvania, New York, N.Y., Feb. 15, 1944.

[44] Federal Communications Commission, National Archives and Records Administration, Records of the Federal Communications Commission. Record Group 173, Box 42, Volume 4. Docket 6651, 31 October, 1944, Official

allocation hearings Western Union vied with AT&T, Raytheon, and IBM for common carrier relay licenses and frequencies.[45] Up to the licensing of cellular telephone systems in the 1980s the Docket 6651 hearings were considered the most significant realignment of radio spectrum in United States history and they set the FCC's spectrum allocation paradigm for the following four decades.[46] Outcomes of Docket 6651 included the shift of FM frequencies to a higher band, creation of the UHF television band, and CB radio. The new allocations also expanded industrial radio applications for aviation and railroad and they allowed for mobile telephony – early car telephones, the precursor technology to cellular and PCS.

Western Union Wireless Experiments

Western Union began experimenting in 1917 with radio telegraphy to increase message capacity and in the 1920s embarked on research to transmit and receive telegrams and later facsimile messages via wireless technology. In 1937 Western Union began using Edwin H. Armstrong's frequency modulation (FM) technology to expand its research program.[47] The 1939 invention of the klystron tube for amplifying microwave signals and advances in radar technology during the Second World War made microwave telecommunications technically and economically viable.[48]

All that remained by the early 1940s was approval by the Federal Communications Commission to deploy the technology and allocation of the super- and ultra- high frequency spectrum to nongovernmental entities. The portion of the spectrum allocated for early commercial microwave

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Report of Proceedings Before the Federal Communications Commission. Docket No. 6651, Relay Systems Hearing Transcript.

[45] Docket 6651, "Western Union Relay Network"

[46] John O. Robinson, Office of Plans and Policy, Federal Communications Commission, *Spectrum Management Policy in the United States: An Historical Account* OPP Working Paper No. 1558-62 (1985); Gregory L. Rosston and Jeffrey S. Steinberg, "Using Market-Based Spectrum Policy To Promote the Public Interest," *Federal Communications Law Journal* 50, no. 1 (December 1997): 88-89; Hugh Slotten, "Rainbow in the Sky: FM Radio, Technical Superiority, and Regulatory Decision-Making," *Technology and Culture* 37, no. 4 (October 1996): 686-720; Slotten, *Radio and Television Regulation*, 119-27.

[47] George C. Hillis, "Telegraphy – Pony Express to Beam Radio," *Annual Report Smithsonian Institution* (1947): 191-205; P.J. Howe, Archives Center, National Museum of American History, Smithsonian Institution, Western Union Telegraph Company Records, Box 3, Folder 1, n.d., "The Western Union Telegraph Company History of Technical Progress, 1935-1945." Volume I, compiled by P.J. Howe; Julian Z. Millar, "A Preview of the Western Union System of Radio Beam Telegraphy, Part I," *Journal of the Franklin Institute* 241, no. 12 (June 1946): 397-413; Julian Z. Millar, "A Preview of the Western Union System of Radio Beam Telegraphy, Part II," *Journal of the Franklin Institute* 242, no. 13 (July 1946): 23-40.

[48] The klystron tube enabled the concentration of electromagnetic energy at higher frequencies than earlier vacuum tubes. Russell H. Varian and Sigurd F. Varian, "A High Frequency Oscillator and Amplifier," *Journal of Applied Physics* 10 (May 1939): 321-27. For a discussion of the significance of the klystron, see Robert Buderi, *The Invention That Changed the World: How a Small Group of Radar Pioneers Won the Second World War and Launched a Technological Revolution* (New York: Simon & Schuster, 1996).

relay services occupied the 1.9 GHz to 4.45 GHz bands. Western Union was assigned frequencies between 4.035 GHz and 4.185 GHz for its microwave system. Microwave telecommunications held the key to the future, promising "economy, dependability and capacity" Western Union vice president Fernand d'Humy told the FCC in a 1943 hearing. He added, "The writing on the wall tells us that the bulk of the overhead communications wires criss-crossing this continent are destined to come down."[49]

Western Union System Development

As it was navigating the regulatory process, Western Union was working to secure patent license agreements with RCA and Edwin Armstrong for proprietary electronics technology.[50] In its October 1944 application to the FCC for microwave spectrum in the Docket 6651 proceedings, Western Union detailed its technical requirements and the equipment and infrastructure necessary to implement its plans for a nationwide relay network. The application included bandwidth requirements, and it detailed how the company planned to ensure the system would not interfere with other telecommunications systems. Also detailed in the application were requirements for relay station placement.[51]

During the fall and winter of 1944 and 1945, Western Union continued its laboratory experiments and initiated field transmission and reception tests with an experimental relay station built in Bordentown, New Jersey.[52] Throughout 1945 the company continued to experiment and refine its radio technology to ensure the system would provide uninterrupted and economical service. For siting its relay equipment the company had to move from the general terms as laid out in its 1944 FCC application for stations spaced from "20-35 miles at the relay points over typical terrain" to the specifics of selecting feasible relay locations and acquiring site control through purchases or leases.[53] Western Union had to select sites based on access to highways and telephone and electrical lines as well as site topography and vegetation to ensure an unbroken line of site profile. The company also had to ensure that each location was within a jurisdiction with zoning conducive to the construction of a relay tower.[54]

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[49] "Transmission of Telegrams by Radio Beams Seen W.U.'s Ultimate Goal," *The Christian Science Monitor*, 25 August 1943, 15.

[50] Millar, "Western Union System of Radio Beam Telegraphy, Part I," 411.

[51] Docket 6651, "Radio Relay Network of the Western Union Telegraph Company."

[52] Howe, "Western Union History of Technical Progress, 1935-1945."

[53] Docket 6651, "Radio Relay Network of the Western Union Telegraph Company."

[54] J.J. Lenehan, "Factors Affecting Location and Height of Radio Relay Towers," *Western Union Technical Review* 4, no. 4 (October 1950): 143-48; Millar, "Western Union System of Radio Beam Telegraphy, Part I," 29-33.

The siting and spacing of relay stations were determined by economic and technological factors. The economic factors called for constructing the least number of relay stations using the greatest spacing technologically feasible. Each microwave relay system consists of property (tower and equipment building), radio equipment (transmitters, receivers, and amplifiers), and multiplex equipment (combines signals into a single path).[55] According to Elmer W. Engstrom, the engineer who chaired RTPB Panel 9 (Radio Relay Systems), the property costs and initial equipment costs were a significant investment in the creation of a relay network.[56] Telecommunications companies like Western Union envisioned taking advantage of economies of scale – large numbers of circuits and multiple services (e.g., telegraph, facsimile, television, and voice) using each relay station – to offset the initial investment in siting and getting online.[57]

Western Union designed its system by incorporating two facility types: terminals and relay stations. In March 1945 the FCC authorized the Western Union to place into service an experimental microwave relay system between New York, New York and Philadelphia, Pennsylvania. This network linking New York and Philadelphia included terminals in Philadelphia and at the company's New York City headquarters. Relays were planned at Bordentown, Ten Mile Run, and Woodbridge, New Jersey. The New York-Washington-Pittsburgh network incorporated the New York headquarters, a rooftop location in downtown Pittsburgh, and a new tower building for the Washington, D.C., terminal. Each terminal was connected by nodes in the network: unattended relay stations with towers and equipment buildings.

Telecommunications companies racing to build out their microwave networks in the 1940s recognized the challenges of implementing an expensive system that relied on uninterruptable service facilitated by automated remote stations packed with expensive radio equipment. "To be commercially feasible, relay points, many of which will be located in relatively inaccessible places, must be designed for unattended operation," explained General Electric Company's H.B. Fancher in testimony before the FCC.[58] Western Union ensured that all of its relay stations were located in groups to ensure timely and cost-effective maintenance and repair. In addition to siting the relays on or near such major transportation routes as U.S. 40 and U.S. 30, the company also recognized that despite its efforts to power each station from the commercial electricity grid, situations would arise where there would be power supply interruptions, hence the incorporation of auxiliary power supplies at each relay point.[59]

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[55] Gerald W. Brock, *The Telecommunications Industry: The Dynamics of Market Structure* (Cambridge, Massachusetts: Harvard University Press, 1981), 199.

[56] Testimony of Elmer W. Engstrom, Docket 6651, "Relay Systems," 31 October 1944. National Archives and Records Administration, Records of the Federal Communications Commission. Record Group 173, Box 42.

[57] H. Carl, *Radio Relay Systems* (London: Macdonald, 1966), 176-77.

[58] Testimony of H.B Fancher, Docket 6651, "Relay Systems," 31 October 1944. National Archives and Records Administration, Records of the Federal Communications Commission. Record Group 173, Box 42.

[59] Millar, "Western Union System of Radio Beam Telegraphy, Part II"; H.M. Ward, "Power Supplies for Microwave Relay Systems," *Western Union Technical Review* 3, no. 4 (October 1949): 133-42; G.B. Woodman, "Maintenance

There are two basic relay site configurations telecommunications companies can select from in designing a network. One configuration involves a concrete tower that encases all of the radio equipment and supports antennas mounted atop it. The other involves the construction of a self-supporting antenna structure (tower) and an equipment building constructed at its base to house equipment.[60] Western Union elected to go with a variation on the latter design using a steel forest fire lookout tower as an antenna support structure and a ground-level concrete equipment building. Western Union's design included mounting radio transmitters and receivers inside the lookout's cabin. The company's standards and specifications for terminal and relay sites were published in several company documents. These specifications include directions for assembling antenna and radio units in the cabs and equipment installation instructions in the equipment buildings.[61]

Relay Towers

After receiving its licenses and permits from the FCC Western Union had to finalize the designs for its facilities and select and acquire relay sites. With RCA providing its radio equipment and the specifications for installing it, all that remained for Western Union was to find an appropriate antenna support structure and standardize the plans and specifications for each relay site. Western Union evaluated several alternative tower designs in developing a standardized antenna support structure for its network. The company eliminated masonry and "tubular steel" towers from consideration and settled on a design based on United States Department of Agriculture Forest Service fire lookout towers.[62]

In March 1945 Western Union engineer H.A. Haenseler began corresponding with the Forest Service in search of an appropriate tower model to suit the company's engineering needs. "We contemplate building for our use a 100 ft. tower which would have a small building on top," wrote Haenseler. "As you no doubt have had considerable experience with steel towers that have small enclosed buildings on top, in connection with your forest fire protective service, it occurred to me that you perhaps have developed definite specifications covering such structures 100 ft. in

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of a Radio Relay System," *Western Union Technical Review* 5, no. 4 (October 1951): 141-47.

[60] Carl, *Radio Relay Systems*, 171-74.

[61] Millar, "Western Union System of Radio Beam Telegraphy, Part II"; Radio Corporation of America (RCA), *Microwave Radio Relay Equipment Instructions*, RCA Victor Division, Engineering Products Department (Camden, New Jersey: Radio Corporation of America, 1947).

[62] Western Union Telegraph Company, Archives Center, National Museum of American History, Smithsonian Institution, Western Union Telegraph Company Records, Box 2, Folder 9, n.d., Uncompleted Manuscript for Engineering Progress 1945-1950, The Western Union Telegraph Company; Millar, "Western Union System of Radio Beam Telegraphy, Part II," 33. Prefabricated towers could be carried on truck beds and assembled at each site thereby reducing the costs of transporting and constructing materials for a concrete building. The lookout tower design enabled engineers to place radio equipment close to the antennas in space. A guyed or narrow tower would not have allowed for the placement of radio equipment close to the antennas.

height."[63] The Forest Service responded by sending drawings and specifications of its "E-Improvements-Lookout Towers."[64]

Subsequent correspondence in spring 1945 between Haenseler and various Forest Service staff concerned specific issues such as stairway design and safety. Western Union was mainly interested in Forest Service accident rates involving ice and snow on tower stairs. Haenseler wrote the Forest Service on 20 April 1945: "We are very much interested in the subject of towers at the present time, an in this connection I am wondering if the open-stair towers present a considerable hazard in ascending and descending during sleet and snow storms.[65]

By late June 1945 Western Union had determined that the specifications for "the light tower" sent by the Forest Service "would be definitely inadequate" for the company's program. "It is our opinion, however, that your standard lookout tower for 14 ft. square cab would be suitable for our requirements covering a radio beam transmission tower," Western Union lines engineer H.H. Wheeler wrote to Forest Service acting chief of engineers H.R. Jones.[66] Unlike earlier radio towers that simply provided basic support for transmitting and receiving antennas, the new microwave towers required adequate support for an enclosure at the top of the tower to house radio equipment that had to be close to the antennas and parabolic reflectors, protected from the weather, and accessible to Western Union maintainers.[67] It is worthwhile to quote at length the remainder of Wheeler's 22 June 1945 letter because it lays out Western Union's engineering requirements for the proposed antenna support structures.

> In arriving at this opinion, we were strongly biased by the knowledge that you have had wide experience with towers and the belief that the tower for 14 ft. square cab has been fully satisfactory to you.
>
> If you can consistently do so, I would appreciate receiving a copy of your latest complete specifications including stair and platform details for your standard lookout towers, 30 to 120 ft. high for a cab 14 ft. square. I, also, would be pleased to receive drawings covering a steel cab on this tower, if such drawings are available.

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[63] H.A. Haenseler, National Archives and Records Administration, Records of the Forest Service. Record Group 95, Box 53, 31 March, 1945, Letter to the U.S. Forest Service

[64] H.R. Jones, National Archives and Records Administration, Records of the Forest Service. Record Group 95, Box 53, 2 April, 1945, Letter to H.A. Haenseler, Western Union

[65] H.A. Haenseler, National Archives and Records Administration, Records of the Forest Service. Record Group 95, Box 53, 20 April, 1945, Letter to the H.R. Jones, U.S. Forest Service

[66] H.H. Wheeler, National Archives and Records Administration, Records of the Forest Service. Record Group 95, Box 53, 22 June, 1945, Letter to the H.R. Jones, U.S. Forest Service

[67] H.P. Corwith and W.B. Sullinger, "Western Union's Microwave Relay System," *Western Union Technical Review* (July 1948): 105; Howe, "Western Union History of Technical Progress, 1935-1945"; Western Union Telegraph Company, "Engineering Progress 1945-1950."

> In making the above request, I have in mind furnishing tower manufacturers with a photostat of your tower drawings together with stair and platform details. We would add to these drawings details of a special cabin that we will require on the top of the tower. We would also incorporate in our request to the tower manufacturers the information outlined in your letter of April 24th regarding gusset plates and channels for stair stringers. If you have any objection to the use of your drawings as indicated above, I will be glad to have you advise me.
>
> The towers we will require for radio transmission will range from 60 to 120 ft. in height, and it is desirable that they have only limited deflection at the top. To help secure rigidity, we propose to use a cab 12 ft. square, and thus reduce the wind pressure on the structure.
>
> It occurred to me, in connection with the matter of the rigidity of the tower, that you might be able to suggest some changes in the tower members or in tolerances covering bolt and rivet holes, which would help secure additional rigidity with relatively small increase in cost. If you have any such recommendations, I would be gratified to receive them.[68]

The Forest Service complied with Western Union's requests and sent the company plans and specifications for a steel lookout tower and a 14' cab. The Forest Service recommended that Western Union contact the International Derrick and Equipment Company to meet its needs for a specially designed steel cab and the Aermotor Company for steel towers. In response to Western Union's query regarding the reduction of wind stresses, the Forest Service recommended eliminating the standard shutters and reducing the glazed area of windows in the cab.[69]

Western Union found the information useful and pursued a tower design based on the Forest Service's L-1601 design detailed in the agency's 1938 *Standard Lookout Structure Plans.*[70] Starting in 1912 the U.S. Forest Service began purchasing Aermotor lookout towers and the company rapidly became the leading supplier for federal and state lookout towers. The Aermotor Company was founded in Chicago in 1888 as a fabricator of windmills, water pumps, and their support towers.[71] In the years bracketing the turn of the twentieth century Aermotor windmills

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[68] Wheeler to Jones, 22 June 1945.

[69] H.R. Jones, National Archives and Records Administration, Records of the Forest Service. Record Group 95, Box 53, 27 June, 1945, Letter to H.H. Wheeler, Western Union.

[70] T.W. Norcross, *Standard Lookout Structure Plans* (Washington, D.C.: United States Department of Agriculture. Forest Service, 1938), 3-3C.

[71] Lindsay Baker, *A Field Guide to American Windmills* (Norman: University of Oklahoma Press, 1985), 37-40; Wes Haynes, *Fire Observation Towers of the New York State Forest Preserve*, National Register of Historic Places Multiple Property Documentation Form (Washington, D.C.: U.S. Department of the Interior. National Park Service,

rapidly spread throughout the Midwest and Eastern United States as a more durable substitute for earlier wood windmill structures.[72] Aermotor's galvanized steel support structure became the standard for lookout towers in the years before the Second World War. Capitalizing on its technical capabilities and functional knowledge, Aermotor expanded its production portfolio to other structures such as electricity transmission towers, radio towers, and emergency siren towers. "For over 50 years Aermotor Company has been designing and building galvanized steel towers for a variety of uses," boasts one 1959 company brochure.[73]

In the fall of 1945 Western Union finalized its engineering requirements for its microwave towers and its plans were reported in October 1945 on the front page of the *New York Times*: "The rural area towers will be steel structures with cabins twelve feet square at the top."[74] "Last July I had a pleasant discussion with you regarding steel towers … for radio beam transmission purposes" wrote Western Union's Haenseler to Forest Service engineer R.S. Henderson 12 November 1945.[75] Haenseler was writing to the Forest Service to request permission to visit one of the "L-1601 Towers with 14' x 14' cab" in the "Middle Eastern or New England States." The Western Union engineer wanted a close-up view of a tower and he wrote to Henderson, "I would of course prefer to visit the one nearest New York City."[76] All of the relay station antenna support structures (towers) in the Philadelphia to New York and the New York-Washington-Pittsburgh systems were constructed using Aermotor galvanized steel towers.

Buildings

To house its main radio equipment and auxiliary power plant, Western Union designed a building to be constructed at the base of each relay tower. The company's design was for a one-story rectangular concrete block building with a shed roof. The building was designed with two doors and one window. The main part of the building was entered through a door in the long axis. The door opened into a radio housing a pair of metal radio equipment cabinets. The remainder of the main interior space was divided into an engine room and a battery room. A square heater room was accessed by a door in the building's rear. Because of the remoteness of the relay station locations, each building was secured against intrusion by solid-core doors, deadbolt locks and exterior padlocks, and metal shutters bolted from the inside.

2001), F2; Peter L. Steere, *National Forest Fire Lookouts in the Southwestern Region, USDA Forest Service*, National Register of Historic Places Multiple Property Documentation Form (Washington, D.C.: U.S. Department of the Interior, National Park Service, 1987), item 8, p. 25.

[72] Haynes, *Fire Observation Towers of the New York State Forest Preserve*, F1 – F2.

[73] "Aermotor Galvanzied Steel Towers." Photocopy of the original in the collection of Michael Pfeifer, U.S. Department of Agriculture, U.S. Forest Service.

[74] "Radio to Supplant Telegraph Wires," *The New York Times*, 23 October 1945, page 1.

[75] A. Haenseler, National Archives and Records Administration, Records of the Forest Service. Record Group 95, Box 53, 12 November, 1945, Letter to R.S. Henderson, U.S. Forest Service

[76] Haenseler to Henderson, 12 November 1947.

Security and protection from the elements weighed heavily in the building's design. Each building housed the station's main radio equipment and apparatus for ensuring an uninterrupted power supply. The relays were connected to commercial power lines by above-ground wires carried on poles. If power was interrupted by damage to the lines or at the generating source, voltage regulators in the buildings switched to the station's battery banks stored in the battery room as an interim power supply until the gas-powered 10 kilowatt generator located in the engine room was operating. At that point the power was switched to the locally generated alternating current until the commercial electricity could be restored.[77]

A window in the side of the building housing the radio equipment cabinets provided daylight to maintainers working in the relay. The engine rooms were designed with a pair of louvered vents operated by motors activated when the engine is running. The vents are protected outside the building by screened metal hoods.[78] To fuel the engine, each building was equipped with a 120-gallon underground gas storage tank. The tanks were secured by poured concrete fill guards and the fuel was conveyed to the engine via conduits in the concrete slab floor.

The buildings were engineered to ensure stable operating temperatures and humidity levels. The oil-burning furnaces located in the heater room prevented condensation in the radio equipment and ensured that the building's temperature would not drop below 40 degrees Fahrenheit. When occupied by maintainers working in the winter, the heater had the added capacity to ensure warm working conditions.[79] A concrete block chimney ventilated the furnace.

With its engineering standards set and refinements underway to its operating parameters, Western Union turned its attention to acquiring sites for its relays throughout the Mid-Atlantic region. Between June 1945 and January 1946, Western Union bought seventeen parcels and leased five on which it built its relays and Washington's Tenley terminal. The properties were small, square outparcels between a quarter of an acre and an acre in area. Each relay site had an access road and a utility right-of-way for electricity poles and lines. The relay sites conformed to the company's standardized design: a steel Aermotor tower topped by a 12' x 12' metal pyramidal roof cab and concrete block equipment building inside a cyclone fence compound. All of the relay sites were completed by May 1947. The landmark Tenley site – the network's Art Deco-influenced architectural gem and futuristic symbol – was completed in March 1947.

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[77] Millar, "Western Union System of Radio Beam Telegraphy, Part II," 33-36; Ward, "Power Supplies for Microwave Relay Systems."

[78] Ward, "Power Supplies for Microwave Relay Systems," 136.

[79] Ward, "Power Supplies for Microwave Relay Systems," 135.

Table 3

Western Union Telegraph Company Microwave Relay Sites

Site name	State	County	Tower Height (1947)	Ownership
Delaware				
Brandywine	DE	New Castle	100'	owned
Maryland				
Severn	MD	Anne Arundel	120'	owned
Cub Hill	MD	Baltimore	100'	leased
Elk Neck	MD	Cecil	100'	leased
Gambrill Park	MD	Frederick	60'	leased
Little Savage	MD	Garrett	120'	owned
Sideling Hill	MD	Washington	100'	owned
New Jersey				
Mt. Laurel	NJ	Burlington	100'	owned
Bordentown	NJ	Burlington	100'	owned
Woodbridge	NJ	Middlesex	100'	owned
Neshanic	NJ	Somerset	100'	owned
New Brunswick	NJ	Somerset	100'	leased
Pennsylvania				
Fort Site	PA	Allegheny	100'	owned
Sellersville	PA	Bucks	100'	owned
Honey Brook	PA	Chester	60'	owned
Mt. Holly	PA	Cumberland	60'	owned
Blue Mountain	PA	Franklin	60'	leased
Bakersville	PA	Somerset	100'	owned
Allegheny	PA	Somerset	60'	owned
Jennerstown	PA	Westmoreland	100'	owned
Red Lion	PA	York	100'	owned

"The era of the pole-less telegraph was heralded here," reported the *Christian Science Monitor* the day after the Western Union Telegraph Company demonstrated its experimental microwave relay network on 22 October 1945.[80] Western Union executives and engineers, in the telegraph company's Manhattan headquarters, unveiled the nation's first commercial microwave relay network to the media and the world. In a scene reminiscent of Samuel F. B. Morse's 1844 demonstration of the first electromagnetic telegraph line linking Baltimore with Washington, D.C., Western Union engineers sent a message from Washington to Philadelphia via wire and then from Philadelphia to New York by "radio beam" using two New Jersey relay stations. A teleprinter produced a greeting from Western Union's Washington manager while simultaneously a facsimile machine across the room printed a handwritten message from Western Union vice president T.B. Gittings in a preview of the nation's first commercial wireless

[80] R. Mullen, "Era of Pole-Less Telegraph Heralded by Western Union," *The Christian Science Monitor*, 23 October 1945, 3.

broadband network. The event captured Western Union's vision of the future of telecommunications in its capacity to simultaneously transmit 2,048 messages.[81]

Experiments continued throughout 1945 and 1946 while the company was acquiring site control over its relay locations and the Washington terminal. Construction of all of the facilities in the New York-Philadelphia network and the New York-Washington-Pittsburgh triangle was completed by the end of 1947. By early 1948 both networks were online and carrying commercial traffic.[82] Even before the first networks were completed Western Union was contemplating extending its microwave system west to Chicago and beyond. Also, technology was changing rapidly and improvements in antenna technology and radio circuitry spurred the company to consider the next phases in its microwave program. Western Union was an industry leader in telecommunications, first in wireline telegraphy in the nineteenth century and then with the introduction of commercial facsimile services in the first half of the twentieth century and ultimately microwave telecommunications in the postwar years. Despite its pathbreaking innovations, the company repeatedly found itself losing its market share to the Bell system. Telephony made it possible to bring telecommunications into the office and home and Western Union's attempts to reinvent itself through technological innovation repeatedly failed. Its microwave network, which was part of a $62 million seven-year capital improvement program, was hailed by Wall Street as a potential cure to the company's financial and labor woes in the 1940s.[83]

The first generation microwave network authorized after the FCC's Docket 6651 hearings quickly morphed into a transcontinental system within a decade and some of the lookout tower antenna support structures were replaced by higher paired and guyed "periscope-feed" towers with passive reflector antennas; others were abandoned and sold to the federal and state governments, regional microwave communications companies, or to emerging entities in mobile telephony. Throughout the 1950s Western Union modified its system to enable some of the sites to relay television signals and other services. Changes in technology, including the introduction of satellite communications in the late 1960s, wireless telephony in the 1970s and 1980s, and the Internet in the 1990s made the postwar microwave equipment obsolete. As its technological needs changed, Western Union abandoned its microwave sites. The sites' elevations and existing infrastructure made them attractive to new users in the public and private sectors.

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[81] J.Z. Millar, "Two Thousand Telegrams Per Minute By Microwave," *Western Union Technical Review* 1, no. 1 (July 1947): 1-8; Mullen, "Era of Pole-Less Telegraph Heralded by Western Union."

[82] Lenehen, "Factors Affecting Location and Height of Radio Relay Towers," 95; Western Union Telegraph Company, Archives Center, National Museum of American History, Smithsonian Institution, Western Union Telegraph Company Records, Box 2, Folder 9, n.d.

[83] "W.U. on the Air: Telegraph Company Adopts High Frequency Radio for Use on Heavy Traffic Circuits. System Dooms Conventional Pole Lines," *Business Week*, 27 October 1945, 20; "Electronics Puts Young Blood in Old Company," *Business Week*, 27 August 1960, 86-96; *Federal Communications Commission Twelfth Annual Report. Fiscal Year Ended June 30, 1946* (Washington, D.C.: Federal Communications Commission, 1947), 26-29; Harold Fleming, "Telegraph Industry Facing Revolution," *The Christian Science Monitor*, 7 February 1947, 17.

In 2005 sixteen of the original relay sites remained in place with varying degrees of physical integrity; only the Jennerstown relay was fully abandoned and not demolished or recycled into another sector of the telecommunications industry. Washington, D.C.'s Tenley terminal remains a valuable piece of vertical real estate and is used by its owner, American Tower Corporation, as an urban antenna farm. Western Union's microwave network failed to save the ailing company. AT&T's monopoly on telecommunications services and infrastructure eroded and new long distance carriers like MCI entered the market. New technologies such as satellites and packet networks added to the new competition rendered Western Union obsolete. The company was sold in 1994 to First Financial Management Corporation; its brand name survived as a money transfer network and the final Western Union telegram was sent in January 2006.[84]

CONCLUSIONS

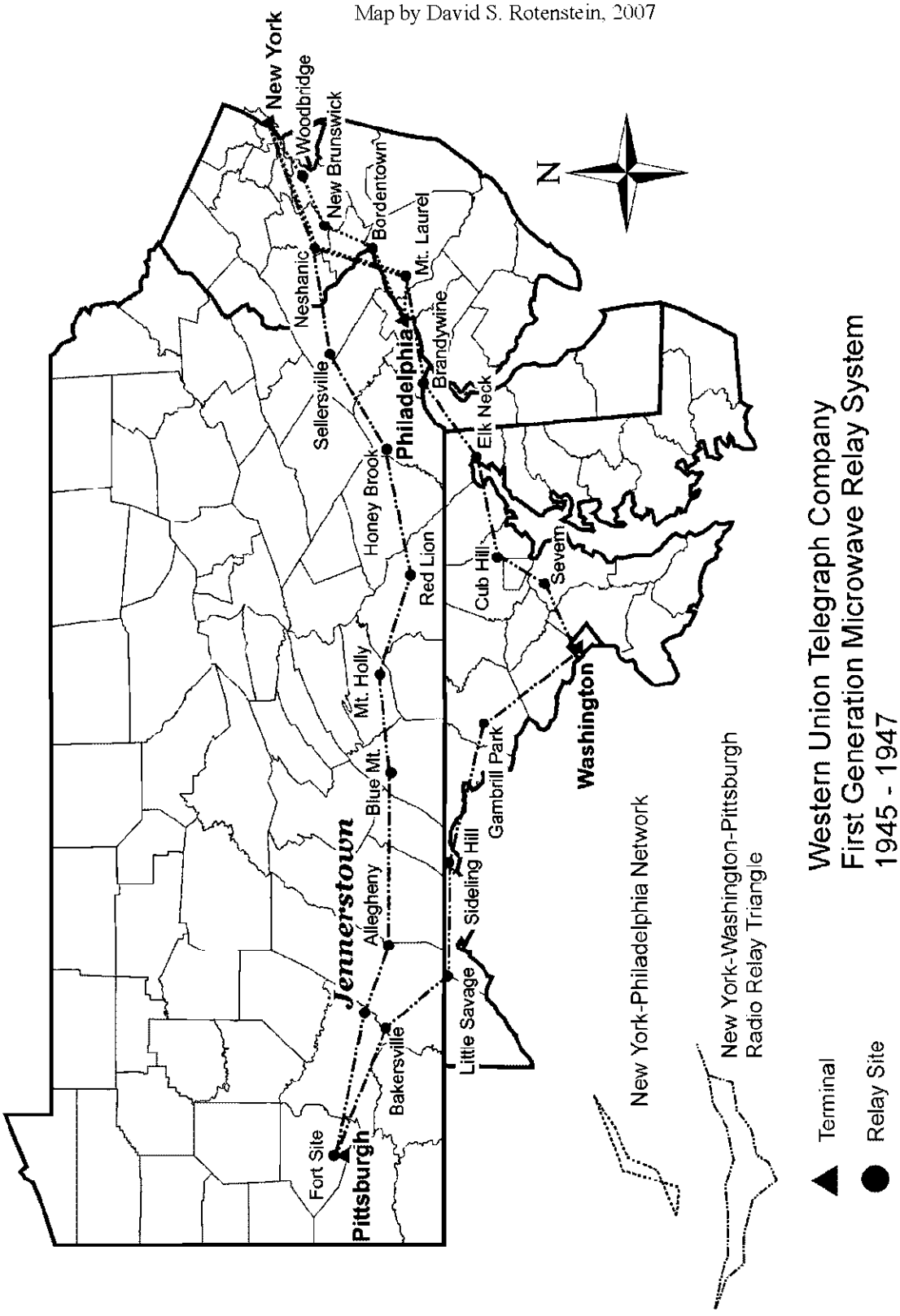
The Jennerstown relay is a remarkably well-preserved element in the Western Union Telegraph Company's first-generation microwave communications system. Unlike other former Western Union sites, the Jennerstown relay has not been razed nor has it been recycled into other telecommunications uses such as cellular or governmental services. The architectural and engineering site template envisioned by Western Union and its contemporaries of unmanned remote relay sites has been continued into the twenty-first century with the proliferation of personal wireless services facilities that consist of an access road leading to a fenced compound with a one-story equipment building and antenna support structure (tower).

Western Union's microwave system changed the American landscape by opening up isolated mountaintops and backyards to high-tech industrial development and contributed towards the creation of a vertical real estate market exploited by commercial telecommunications companies. Travelers along the Lincoln Highway (U.S. 30) and the old National Road (U.S. 40) during the postwar years saw towers rising above the forest canopies and silhouetted on the horizon. When they were built, the towers were welcomed. But by the turn of the twenty-first century the industrial structures had become considered by many as blight and unwelcome visual intrusions. Sites like Jennerstown and the other surviving Western Union relays, plus Washington's Tenley terminal, are key repositories of architectural and engineering information that can provide insights into economic, technological, and social history.

[84] Valerie Bauerlein, "Western Union's Last Telegram Marks the Conclusion of an Era," *The Wall Street Journal*, 3 February 2006, B3; Mike Musgrove, "The Telegram, 1844-2006," *The Washington Post*, 3 February 2006, D-1.

APPENDIX A: WESTERN UNION SYSTEM MAP

Map by David S. Rotenstein, 2007



APPENDIX B:
WESTERN UNION FIRST GENERATION MICROWAVE RELAY SITES AND TERMINAL STATIONS

This appendix contains summaries of each of the Western Union Telegraph Company microwave relay and terminal sites. It is arranged by type of site (terminals, then relays) and then by states.

TERMINALS

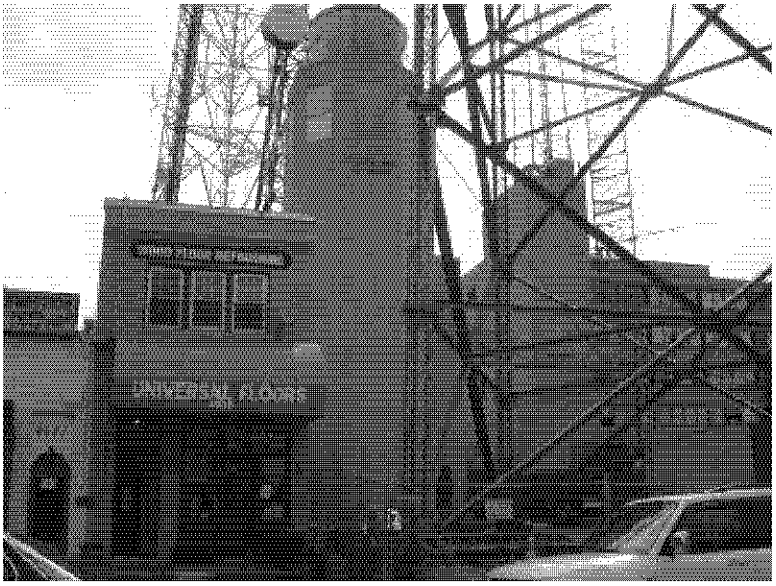
Site Name: New York
Call Sign: KEA73
State: New York
County: New York
Municipality: New York
Address: 60 Hudson Street
Type of Facility: Terminal
Original Tower Height: rooftop

No Photo

Western Union Telegraph Company's corporate headquarters were located in an Art-Deco-style building designed by architects Voorhees, Gmelin & Walker and completed in 1930. A pair of parabolic reflector antennas was collocated on the roof of the penthouse and the radio equipment was housed inside the building.[85] Western Union remained at the 60 Hudson Street location until 1973. The office building currently houses major telecommunications firms and other businesses.

[85] Millar, "Western Union System of Radio Beam Telegraphy, Part II," 29-30.

Site Name: Tenley Site
Call Sign: KGB34
State: District of Columbia
County: DC
Municipality: Washington
Address: 4623 41st Street NW
Type of Facility: Terminal
Original Tower Height: 90'



Western Union's Washington terminal is a communications tower and attached equipment wing located in a mixed residential-commercial neighborhood in Washington, D.C.'s Tenleytown neighborhood. The facility was constructed on a rectangular block on the east side of 41st Street N.W. immediately north of 41st Street's intersection with Wisconsin Avenue.

The tower is an octagonal masonry structure that rises 90' above the ground level. It measures 9′-3″ on each side and is attached to the square equipment wing which measures 38' x 40'. The tower was built on a concrete foundation (below-grade footer) and is constructed of brick walls. Its exterior is clad by dressed limestone facing. There are five internal floors within the tower and an 11'-high aluminum turret housing microwave antennas caps the flat roof. The first floor consists of an office space and maintenance work spaces; access to the upper portions of the tower is via a metal staircase in the eastern side of the tower core. Entry to the tower is through a vestibule and door leading from the rear wing.

The tower has rectangular metal-frame windows in the north and south facades at the first, second, and third story levels. The "Tower Floor" (upper) level has eight (one for each side) removable rectangular fiberglass and aluminum panels that conceal the enclosed microwave antennas. The tower walls rise to a low parapet around the flat roof and narrow walkway between the parapet and the aluminum turret.

The tower's decoration is minimal, its style informed by the moderne. Slight curves and tapering along the parapet create an entasis effect. The only ornamentation is the "Western Union" corporate name in 13'-high bronze letters on the tower's west façade.

The attached wing, located on the tower's east side (rear), was built as a two-story reinforced concrete building to house a battery room, engine room, and other parts of the facility's physical plant on the first floor and communications equipment on the second story. The facility's main

entrance is through a door on the north side of the tower into the wing's west façade. The rectangular metal door is set in a rectangular projecting bay with fluting and the building's address – "4623" – is in bronze numerals set above the door. The wing's west façade is symmetrical: the tower rises in the center and is flanked on the north by the building entrance and the south by a rectangular metal-frame window.

The tower and wing were modified several times during the facility's history. Briefly, in 1948, a 43' experimental metal antenna was mounted on the turret. In 1962, Western Union constructed a one-story reinforced concrete addition to the wing on which it built a four-legged lattice tower to mount additional microwave antennas. The added tower rises 155' above the addition.

While conducting the tests on the New York and Philadelphia system, Western Union applied to the FCC to construct a fully functional radio relay triangle between New York, Washington, and Pittsburgh. On 7 November 1945, the FCC granted Western Union a "Radio Station Construction Permit" to build its facility at:

> 41st Street, near Wisconsin Avenue … to communicate with experimental stations of the permittee as necessary for development of commercial point to point radio communications between New York City, New York, Pittsburgh, Pennsylvania, Washington, D.C., and Philadelphia, Pennsylvania, (via intermediate relay stations).[86]

Western Union was able to place rooftop antenna installations on existing buildings for its New York, Philadelphia, and Pittsburgh terminals. In Washington, however, the company required a new facility in the District's highest-elevation neighborhood, Tenleytown. The site had been recognized since the 1920s as a prime location for broadcasting. Earlier efforts to construct a radio tower in the vicinity of the parcel Western Union sought failed when local residents in 1940 successfully blocked the approval by the District of Columbia's Board of Zoning Adjustment of a proposed 200' tower requested by radio station WINX.[87]

Western Union bought the property at 4623 41st Street NW in September 1945.[88] The next month, the *Washington Evening Star* reported that the company was planning to build a 90' tower "for wireless transmission of messages along a chain of towers."[89] Western Union hired

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[86] FCC File No. T1-PE-530A. Application appended to the Western Union District of Columbia building permit.

[87] "Radio Tower Hearing Set for June 19," *The Washington Post*, 9 June 1940, 13; "Radio Towers Protested at Zoning Hearing," *The Evening Star* (Washington, D.C.), 20 June 1940, B-1.

[88] District of Columbia Land Records. Deed Book 8164, p. 331.

[89] *Washington Evening Star*, October 23, 1945.

Washington, D.C., architect Leon Chatelain Jr. (1902-1979) to design the new Tenley transmission tower at the site, which was at 397' above sea level.[90] Chatelain began drafting renderings of the new tower as early as October 1945 and his firm was busy drafting plans for the facility by December of that year. In June 1946, Western Union received a building permit from the District of Columbia to "erect one 2-story limestone & brick building & 90 ft. tower."[91] Construction began in July 1946 when Western Union's contractor, Jeffress-Dyer, Inc., demolished a one-story stuccoed frame house at the site; the tower was completed on 24 March 1947.

The Tenley site designed by Leon Chatelain Jr. was modified several times during its use by Western Union. In 1948, Chatelain's engineers designed a temporary 42' guyed antenna to be mounted on the tower's original turret. The building permit was issued in June 1948, however it is unclear if the extension was ever added.[92] In 1963, Chatelain again prepared designs for Western Union to add a third story to the tower's equipment wing and a four-legged 165' self-supporting lattice tower with microwave horn reflector antennas. The 1963 lattice tower and horns remain on the building.

Chatelain's tower is the only architect-designed facility in the first generation Western Union system. Chatelain's modernist tower is an outstanding example of radio transmission architecture and was built in accordance with prevailing industry standards: "Because a radio transmitter is a very modern phenomenon, it seems appropriate that the transmitter building should usually follow a style belonging within that broad range roughly known as 'contemporary'".[93]

Western Union continued to operate the facility until its sale in 1990 to Micronet, Inc. In 1997, Boston, Massachusetts-based American Tower Systems (now, American Tower Corporation) acquired Micronet and all of its assets – including the Tenley site and another Western Union facility in the radio relay triangle in Severn, Maryland. The Tenley site currently is used as communications facility, mainly for personal wireless services.

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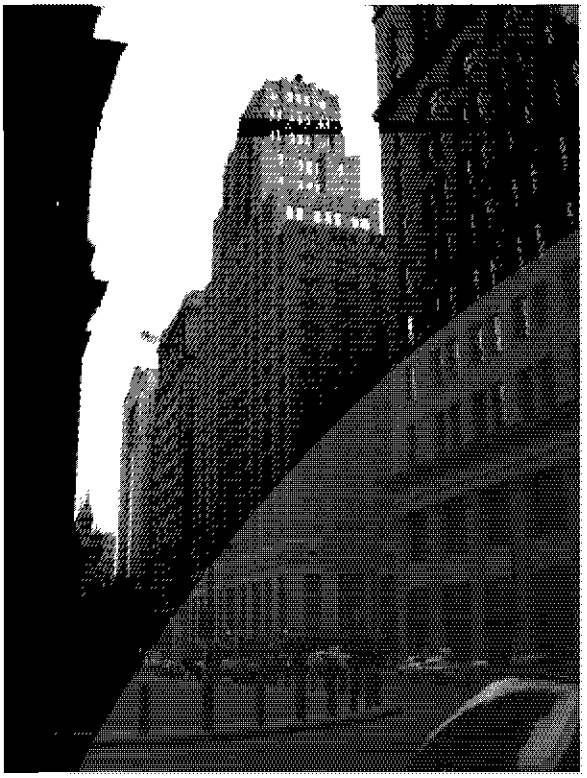
[90] Chatelain received his architecture degree from The George Washington University and he began practicing in Washington in 1930. He served as the president of the American Institute of Architects (1956-1958) and was a Fellow of the Royal Architects Institute of Canada. Among the buildings he designed are the Equitable Life Insurance Company building (now occupied by Fannie Mae), the C&P Telephone building in Bethesda, Maryland, and the Federal Deposit Insurance building in Washington. He also designed an underground magazine for Nike missile batteries during the Cold War.

[91] District of Columbia Building Permits. National Archives. Building Permit No. 286579.

[92] Photographs of the tower taken in November 1949 do not show the extension.

[93] Western Electric Corporation, *The Architecture of Broadcast Transmitter Buildings*, in *Western Electric Oscillator*, 9 (1948): 28.

Site Name: Philadelphia
Call Sign: KGB28
State: Pennsylvania
County: Philadelphia
Municipality: Philadelphia
Address: Market Street Bank Building
Type of Facility: Terminal
Original Tower Height: rooftop'



Antennas and radio equipment for the Philadelphia terminal were located on the roof of the Market Street National Bank. The 24-story art deco style building was designed in 1929 by Philadelphia architects Ritter and Shay and constructed in 1930.

Site Name: Pittsburgh
Call Sign: KGB43
State: Pennsylvania
County: Allegheny
Municipality: Pittsburgh
Address: 710 Smithfield St. (Chamber of Commerce bldg.)
Type of Facility:
Original Tower Height: rooftop

No Photo

Western Union had its Pittsburgh offices in the Chamber of Commerce Building, a 16-story building constructed in 1917. The Pittsburgh terminal (antennas and radio equipment) was located on the building's roof and a short three-mile hop linked the Pittsburgh terminal to the Fort Site. The office building survives in downtown Pittsburgh.

RELAYS

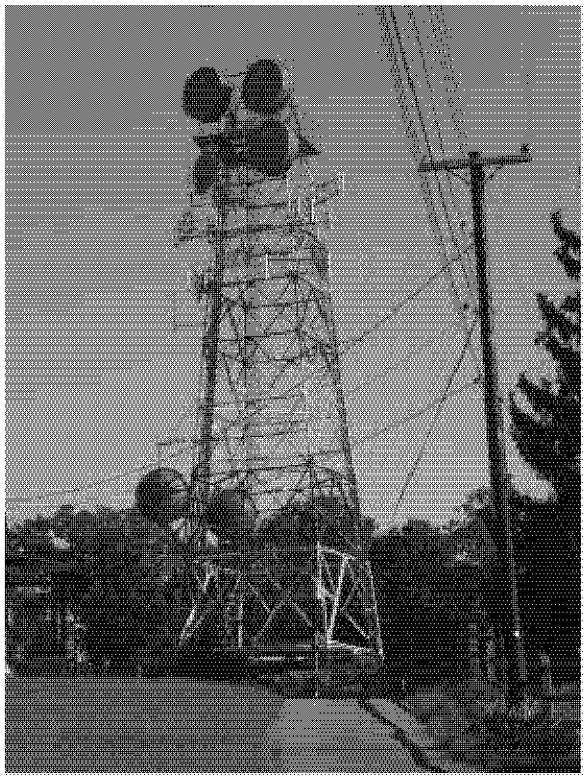
Site Name: Brandywine
Call Sign: KGB29
State: Delaware
County: New Castle
Municipality: Brandywine Hundred
Address: West Side Ebright Road
Type of Facility: Relay
Original Tower Height: 100'

The only Western Union relay located in the state of Delaware was built in New Castle County north of Wilmington near the Pennsylvania state line at the intersection of Ebright Street and Ramblewood Drive. Known locally as "Tower Hill," this location at 447.85' above mean sea level is the highest natural elevation in Delaware. Western Union constructed a 100' tower at this site on property the company purchased from Richard and Evelyn Merchant on 18 September 1945. The company paid $1,200.00 for 0.992 acre and it owned the site until 1974 when New Jersey-based Lutner, Inc. bought it for $6,000.00. Four years later, Lutner sold it to amateur radio enthusiast Robin McCray. The tower currently is used by amateur radio and commercial tenants.[94]

In 2003 the tower, cab, and equipment building were intact. Alterations to the tower were limited to the collocation of multiple whip (omni-directional) antennas.

[94] New Castle County Deed Book I-45, p. 264 (Merchants to Western Union); New Castle County Deed Book Q-89, p. 313 (Western Union to Lutner); New Castle County Deed Book, p. 186 (Lutner to McCray).

Site Name: Severn
Call Sign: KGB33
State: Maryland
County: Anne Arundel
Municipality:
Address: 1620 Thompson Road
Type of Facility: Relay
Original Tower Height: 120'



Western Union constructed a 100' relay tower in rural Anne Arundel County on property it acquired 18 September 1945 from Leonard and Harriet Griffith. The company paid $1,700.00 for 0.45 acre (19,602 square feet) for an outparcel located north of Thompson Road in a subdivision first platted in 1914. The Severn facility was constructed before January 1947 and its equipment had been delivered by the first week in February 1947. Western Union owned and operated the Severn Relay until 1990 when Micronet, Inc., a communications facility construction and management company purchased it. In 1997, American Tower Systems, Inc. (predecessor to American Tower Corporation, Inc.), acquired Micronet's assets in a $70.25 million purchase. In 1998, the property was transferred from American Tower Systems, Inc., to American Tower, L.P.[95]

The Severn relay station has been continuously used in the communications industry since its construction in 1947. The tower and equipment building remain at the site. In 1950, a 1.5-story house was built in the larger parcel, south of the Western Union compound and the site currently is located behind the house's rear yard and garage. Prior to 2002, the cab had been removed and the current owner, American Tower Corporation, removed the interior stairway between 2003 and 2004. The site's owner leases space to telecommunications firms who have mounted parabolic and whip antennas at various points along the tower.

[95] Anne Arundel County Deed Book JHH-341, p. 150 (Griffiths to Western Union); Anne Arundel County Deed Book 5093, p. 850 (Western Union to Micronet).

Site Name: Gambrill Park
Call Sign: KGB47
State: Maryland
County: Frederick
Municipality: City of Frederick
Address: East side Gambrill Park Road
Type of Facility: Relay
Original Tower Height: 60'

This relay site is located on Catoctin Mountain at an elevation of 1,700' above mean sea level. In November 1945 Western Union executed a ten-year renewable lease with the Mayor and Aldermen of Frederick for a 0.92-acre parcel east of Ridge Road. Western Union paid $360.00 annually in rent and was granted the rights to "erect on the premises a tower to be used for the relaying radio signals, and will include in such tower an enclosed cab suitable for forestry observation." Western Union, in turn, agreed to allow the City of Frederick and the State of Maryland "the right to use and occupy such cab for fire lookout and similar purposes."[96] A 60' tower was built at this site.

Western Union occupied the site until 1990. After the Western Union site went into service, other telecommunications entities, public and private, built facilities close to the Western Union relay. In 1983, AT&T built a tower south of the Western Union relay and the two companies

[96] Frederick County Land Record Book 450, p. 584.

entered into a joint use and maintenance agreement for the access road leading to the two sites from Ridge Road. Western Union terminated its lease with the city and the site, including equipment, buildings, and structures, was leased by the U.S. Federal Aviation Administration.[97]

In 2003 the tower remained in place and was in use by the FAA. The cab had been removed and the equipment building had been replaced by one clad in vinyl siding. The former Western Union relay site became the anchor for an antenna farm that includes five telecommunications facilities.

Site Name: Sideling Hill
Call Sign: KGB46
State: Maryland
County: Washington
Municipality:
Address: National Pike
Type of Facility: Relay
Original Tower Height: 100'

Located on Sideling Hill Mountain in northern Washington County, Maryland, at an elevation of 1,591' above mean sea level, this relay site was bought by Western Union 21 November 1945. The company paid the Woodmont Rod and Gun Club of Baltimore City $500.00 for a 0.92 acre parcel adjacent to U.S. 40. The company built a 100' tower at this site.[98]

During the early 1950s, the State of Maryland relocated a portion of U.S. 40 over Sideling Hill Mountain and it acquired a portion of Western Union's access road, requiring the company to build a new access road to its relay site from the highway. The site was acquired by the State of Maryland and currently is used by the Maryland State Police.[99]

The tower, cab, and equipment building were intact in 2003. Alterations to the tower include the mounting of parabolic and omni-directional antennas. The Western Union installation was the first of five towers constructed in proximity to each other along the crest of Sideling Hill Mountain along U.S. 40.

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[97] Frederick County Land Record Book 1637, p. 106 (Western Union-AT&T agreement); Frederick County Land Record Book 1627, 158 (City of Frederick to the United States of America).

[98] Washington County Land Record Book 232, p. 343.

[99] Washington County Land Record Book 327, p. 569; Maryland State Highway Plat 13211.

Site Name: Little Savage
Call Sign: KGB45
State: Maryland
County: Garrett
Municipality:
Address: East side SR 546 (Finzel Road)
Type of Facility: Relay
Original Tower Height: 120'

This relay site is located east of Maryland Route 546 approximately 1.12 mile north of U.S. 40 in Garrett County, Maryland. In June 1945 Western Union placed an option to purchase a 0.236 acre outparcel in property owned by Clarence and Ella McKenzie on or before 29 November 1945. Western Union paid the McKenzies $20.00 for the option to buy the land for $210.00. On 26 November 1945 Western Union exercised its option to buy the land on which they built a 120' tower at an elevation of 2,800' above mean sea level. The company held the site for nearly twenty years, selling it to the Maryland State Police in February 1967 for $12,000.00.[100] The site in 2003 was owned by the State of Maryland and it remains in use as a police antenna support structure.

The tower, cab, and building are intact. The tower has been altered by the addition of whip antennas and the equipment building has been clad by vinyl.

[100] Garrett County Deed Book 136, p. 296 (Western Union option to purchase); Garrett County Deed Book 137, p. 348 (McKenzies to Western Union)' Garrett County Deed Book277, p. 341 (Western Union to the State of Maryland).

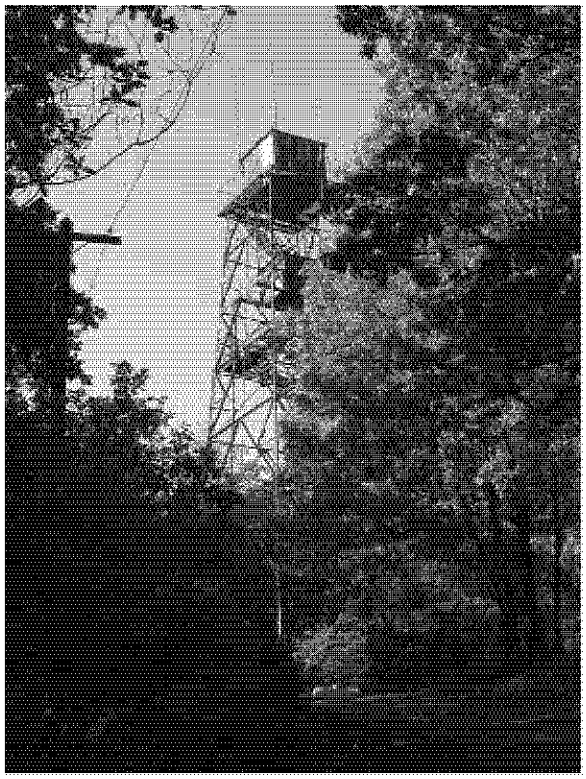
Site Name: Cub Hill
Call Sign: KGB32
State: Maryland
County: Baltimore
Municipality:
Address: N/A
Type of Facility: Relay
Original Tower Height: 100'

No Photo

This Western Union relay site is located in Baltimore County east of Old Harford Road near the community of Carney. In 1948 the company executed a lease with the developer of a new subdivision, Greenwood Homes, Inc., that would have allowed them to build a tower, appurtenances, and an access road contingent upon receipt of permits from the FCC and the State of Maryland. In October 1951, the company was released from the terms of the lease because it had not secured the required permits; according to the release Western Union notified Greenwood Homes in October 1949.[101] Western Union records indicate that it built a 100' tower in the Cub Hill vicinity and the coordinates and elevation listed in Western Union technical documents correspond to the Greenwood Homes parcel. Surviving documents do not provide more details about the Cub Hill relay site.

[101] Baltimore County Deed Book 1722, p. 415 (Lease to Western Union Company); Baltimore County Deed Book 2028, p. 173 (Release).

Site Name: Elk Neck
Call Sign: KGB31
State: Maryland
County: Cecil
Municipality:
Address: Black Hill, Elk Neck State Forest
Type of Facility: Relay
Original Tower Height: 100'



Western Union's Elk Neck Relay Station was constructed on a parcel leased from the State of Maryland Department of Forests. In 1937 the state created a 120-acre state forest it called Elk Neck State Forest. The forest was located south of Elkton on a peninsula between the Chesapeake Bay and the Elk River. Western Union, by 1947, constructed a 100' tower at this site known as Black Hill at an elevation of 273' above mean sea level. The tower, cab, and equipment building remain at the site and are used by the park police as a radio repeater site. The tower has been altered by the placement of whip antennas.

Site Name: Neshanic
Call Sign: KEA77
State: New Jersey
County: Somerset
Municipality: Hillsborough Township
Address: 380 Zion Road
Type of Facility: Relay
Original Tower Height: 100'

This relay station served both the Philadelphia-New York network and the New York-Washington-Pittsburgh network. Constructed on Sourland Mountain in rural Somerset County at an elevation of 546' above mean sea level, this relay station originally was constructed as a 100' tower. Western Union paid $600.00 to Michael and Doris Fatto in October 1945 after exercising an option to purchase the property executed in June 1945. The company owned the relay site until 1969, after which the site was transferred several times to various telecommunications entities. It currently is owned by American Tower Corporation.[102]

The Neshanic relay was an instrumental site in Western Union's early field experiments begun 1945.[103] By 1947 when Western Union began seriously turning its attention towards using its relay sites for television transmissions the Neshanic site had been identified as one of two candidates for television equipment in the original system.[104] At some point in its early years in operation the Neshanic tower was raised from its original 100' to 120'.[105] The tower currently rises to 200'. Surviving Western Union documents do not explain the deviations in design seen in this structure.

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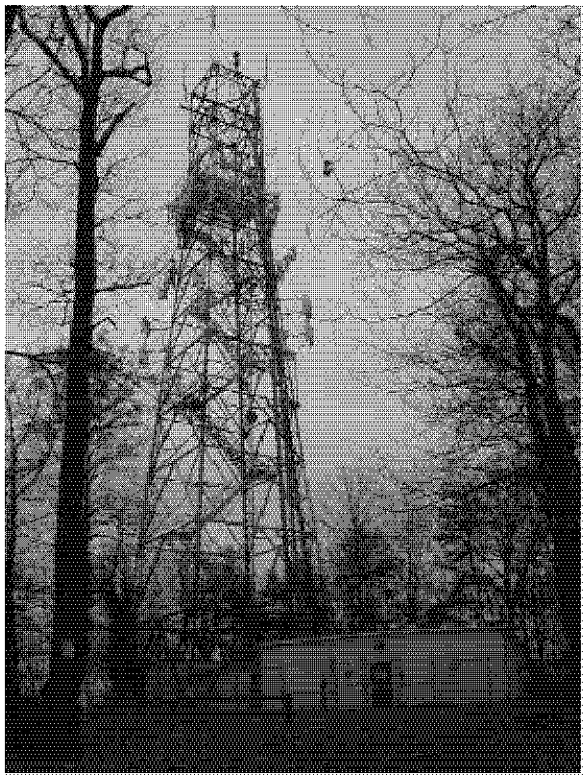
[102] Somerset County Deed Book 640, p. 400 (Option); Somerset County Deed Book 645, p. 115 (Fattos to Western Union); Somerset County Deed Book 1202, p. 491 (Western Union to David Batcho).

[103] Howe, "Western Union History of Technical Progress, 1935-1945."

[104] F.E. d'Humy, National Archives and Records Administration, Records of the Federal Communications Commission. Record Group 173, Box 35, Volume 4. Docket 6651, 5 May 1947, 1947, Special Report Submitted by Mr. F.E. d'Humy, Vice President in Charge of Development and Research, on Behalf of the Western Union Telegraph Company

[105] Howe, "Engineering Progress 1945-1950."

Site Name: Mt. Laurel
Call Sign: KEA76
State: New Jersey
County: Burlington
Municipality: Mount Laurel Township
Address: Haynesport & Mt. Laurel roads
Type of Facility: Relay
Original Tower Height: 100'



The Mt. Laurel relay station was built on a 160' hill, the namesake of the community in which it was built. The parcel on which Western Union built its relay is located at the intersection of Evesboro and Meetinghouse roads in Mt. Laurel State Park. In October 1945 Western Union purchased 21 acres from the State of New Jersey for $1,200.00. The company then conveyed all but a 0.91 acre outparcel back to the State of New Jersey. Western Union owned the site until 1990 when it sold the property to Micronet, Inc. Micronet in 1996 sold its assets, including the Mt. Laurel site, to the American Tower Corporation, the facility's current owner.

The tower remains at the site, however the cab has been removed. Several one-story buildings are located inside the site's compound, presumably built to replace the original Western Union building. Alterations to the tower include an extension raising it to 179', presumably added after Western Union abandoned the site and the original equipment cab was removed; cellular/PCS panel antenna arrays and whip antennas have been attached to the tower.

Site Name: New Brunswick
Call Sign: KEA74
State: New Jersey
County: Somerset
Municipality: Franklin Township
Address: 63 Old Georgetown Road
Type of Facility: Relay
Original Tower Height: 100'

No Photo

This relay site in Somerset County originally was leased by the Radio Corporation of America (RCA) in November 1944. It was one of the first two experimental sites established in the New York-Philadelphia network. In 1949 Western Union executed a five-year lease with owner Selma Anderson after succeeding RCA as the site operator. The lease was renewable and it is unclear when Western Union abandoned the site. Anderson sold the property, including the former Western Union tower, in 1967 to Albert Broda who continued to rent the site to telecommunications companies until 1970 when he sold it to Trans-Communications Enterprises, Inc. Trans-Communications subsequently merged with Transportation Microwave Corporation, which in turn was acquired by Southern Pacific Communications Company. In 1983, GTE acquired the company and its assets, including the New Brunswick relay site. In 1985, GTE – then doing business as GTE Sprint Communications Corporation – sold the site to AAT Communications. The property's current owner, Tower Broadcasting Corporation bought the site in 1997.[106]

The site in 2003 was occupied by a 274' self-supporting lattice telecommunications tower. According to FCC Antenna Structure Registration database records, the current tower was constructed by AAT in 1999.[107]

[106] Somerset County Deed Book 724, p. 524 (Anderson to Western Union); Somerset County Deed Book 1159, p. 433 (Anderson to Broda); Somerset County Deed Book 1223, p. 424 (Broda to Trans-Communications Enterprises); Somerset County Deed Book 1540, p. 155 (GTE Sprint Communications Corporation to A.A.T. Communications Corp.); Somerset County Deed Book 4451, p. 39 (AAT to Tower Broadcasting Corporation).

[107] Federal Communications Commission Antenna Structure Registration No. 1056213.

Site Name: Woodbridge
Call Sign: KEA71
State: New Jersey
County: Middlesex
Municipality: Woodbridge Township
Address: N/A
Type of Facility: Relay
Original Tower Height: 100'

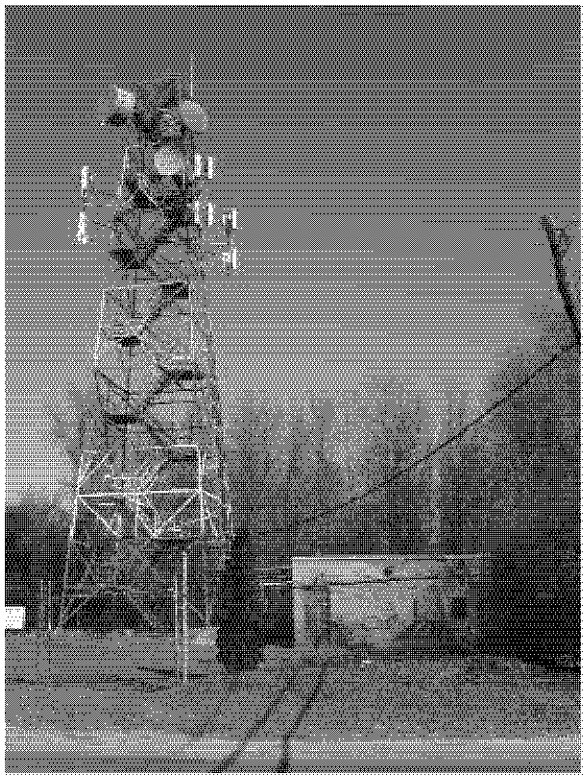
No Photo

The company constructed it in 1946 to correct path obstructions between two other New Jersey sites in the New York-Philadelphia network: New Brunswick and Bordentown. In July 1946 Western Union leased a parcel in Woodbridge Township, Middlesex County, New Jersey, from Hans and Mathilda Eriksen. The company was bound to a $75.00 annual rent and the instrument gave Western Union the option to buy the property for $1,500.00. The lease was renewed in 1951, with the rent elevated to $100.00 a year and the purchase option preserved. Two years later, in November 1953, Western Union exercised its option to buy the property "on which there is located a micro-wave tower and telegraph relay station." Western Union sold the property in 1973 to Lutner, Inc.[108]

The Woodbridge relay station was removed prior to 2003. The site where Western Union built the relay has been absorbed by a subdivision south of the New Jersey Turnpike.

[108] Middlesex County Deed Book 1315, p. 349 (Eriksen lease to Western Union); Middlesex County Deed Book 1564, p. 182 (Eriksen lease renewal); Middlesex County Deed Book 1731, p. 287 (Eriksen to Western Union sale); Middlesex County Deed Book 2831, p. 198 (Western Union to Lutner).

Site Name: Bordentown
Call Sign: KEA72
State: New Jersey
County: Burlington
Municipality: Bordentown Township
Address: Rising Sun Road
Type of Facility: Relay
Original Tower Height: 100'



The Bordentown relay was one of the earliest experimental sites constructed in the Western Union system. Along with the New Brunswick relay, it was one of two New Jersey sites first established an operated experimentally by RCA. Completed late in 1944, the Bordentown relay included a 100' tower built at 98' above mean sea level and it began testing with signals originating from RCA's Camden headquarters.[109] Western Union acquired title to the property along Rising Sun Road in 1952. In 1967 the site was sold; the deed conveying it from Western Union to the new owner noted an existing lease with the Federal Bureau of Investigation.[110] In 2003 the site was occupied by Comcast Cable Company.

The Bordentown relay was frequently pictured in much of Western Union's early reports documenting its microwave system. The 1940s photos show a one-story side-gabled building and a lookout tower with different truss configurations than all of the other Western Union sites. Also, its concrete foundation piers are larger and higher than the ones anchoring the other Western Union towers. In 2003 the tower was intact and painted in the alternating white and international orange color tower marking pattern. The cab was missing and the side-gabled equipment building had been replaced by a one-story shed roof building.

[109] Howe, "Western Union History of Technical Progress, 1935-1945."

[110] Burlington County Deed Book 1122, p. 470 (Burke to Western Union); Burlington County Deed Book 1657, p. 872 (Western Union to Miller).

Site Name: Sellersville
Call Sign: KGB35
State: Pennsylvania
County: Bucks
Municipality: West Rockhill Township
Address: Tower Road
Type of Facility: Relay
Original Tower Height: 100'

Western Union built this relay site in West Rockhill Township, Bucks County, Pennsylvania, through its Telegraph Realty Company subsidiary in November 1946. The realty company paid $100.00 for 40,000 square feet of "mountain land" owned by Monroe G. Koffel. The property was transferred to the Western Union Telegraph Company in 1947. Western Union sold the relay site to Bucks County in 1966 for $5,000.00.[111]

The Sellersville relay site was built with a 100' tower. The tower, cab, and equipment building remained intact and were in use by Bucks County in 2005. The tower was painted in the alternating white and international orange marking scheme. Alterations to the tower included the mounting of parabolic and whip antennas.

[111] Bucks County Deed Book 765, p. 126 (Koffel to Telegraph Realty); Bucks County Deed Book 833, p. 194 (Telegraph Realty to Western Union); Bucks County Deed Book D-1842, p. 146 (Western Union to Bucks County).

Site Name: Bakersville
Call Sign: KGB41
State: Pennsylvania
County: Somerset
Municipality: Jefferson Township
Address: SR 31
Type of Facility: Relay
Original Tower Height: 100'

This relay site was constructed in Jefferson Township, Somerset County, Pennsylvania. Located approximately 0.23 mile south of Pennsylvania State Route 31 at an elevation of 2,870' above mean sea level, Western Union purchased this property in October 1945 through its Telegraph Realty Company subsidiary after executing an option to buy it from landowner Frank H. Showman in June 1945 for $500.00. When the Telegraph Realty Company liquidated its assets in 1947 title to the site was transferred to the parent company. Western Union owned the site until March 1990 when it sold the property to the United States for $70,000.00.

Western Union constructed a 100' tower at this site. During its transition, likely in the 1950s, to second generation microwave equipment the tower was removed and replaced with what the company described as twin-masts of the "H type," essentially a pair of guyed lattice towers, outfitted with passive reflector or parabolic antennas.[112] In 2004 the site had the twin mast towers with parabolic and whip antennas attached.

[112] Howe, "Engineering Progress 1945-1950."

Site Name: Allegheny
Call Sign: KGB40
State: Pennsylvania
County: Somerset
Municipality: Shade Township
Address: US 30
Type of Facility: Relay
Original Tower Height: 60'

No Photo

Western Union constructed this relay in Shade Township, Somerset County, north of U.S. 30 (Lincoln Highway). Located at an altitude of 2,930' above mean sea level, this 0.918 acre parcel was acquired by the Telegraph Realty Company in November 1945 from the heirs of Margaret Manges for $500.00. Two years later the property was transferred to the realty company's parent, the Western Union Telegraph Company when the realty company liquidated its assets. Western Union owned the site until 1971 when it was sold to the Pennsylvania Turnpike Commission for $15,000.00.[113]

The company built a 60' tower at this relay site. In 2004 the former relay site had been abandoned by the Pennsylvania Turnpike Commission and the tower and appurtenances removed. FCC records suggest that the Western Union tower may have been removed between 1971 and 1999.[114]

[113] Somerset County Deed Book 350, p. 332 (Manges Heirs to Telegraph Realty); Somerset County Deed Book 375, p. 427 (Telegraph Realty to Western Union); Somerset County Deed Book 949, p. 190 (Western Union to Pennsylvania Turnpike Commission).

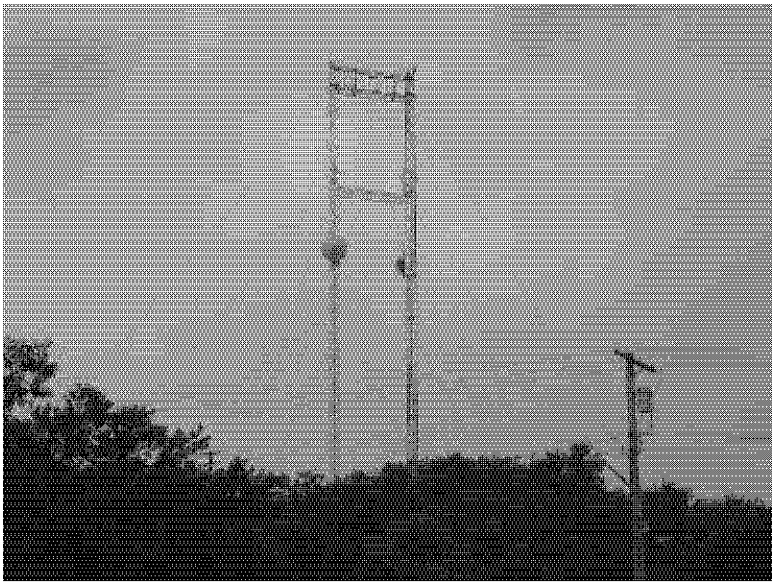
[114] Federal Communications Commission Antenna Structure Registration No. 1200403.

Site Name: Blue Mountain
Call Sign: KGB39
State: Pennsylvania
County: Franklin
Municipality: Letterkenny Township
Address: Broad Mountain Road
Type of Facility: Relay
Original Tower Height: 60'

This relay site was constructed on Clarks Knob at an elevation of 2,338' above mean sea level in Letterkenny Township, Franklin County, Pennsylvania. The site is located within the Buchanan State Forest and it appears to have been one that Western Union leased from the State of Pennsylvania. The site in 2004 was controlled by the Pennsylvania Turnpike Commission.

Western Union constructed a 60' tower at this relay site. The tower and cab remain intact; however, the equipment building has been replaced. This relay station was one of the first generation sites modified by Western Union to accommodate a second equipment cabin on the platform beneath the upper cab. Alterations to this tower include mounted parabolic and whip antennas.

Site Name: Fort Site
Call Sign: KGB42
State: Pennsylvania
County: Allegheny
Municipality: Pittsburgh
Address: Chicago Road
Type of Facility: Relay
Original Tower Height: 100'



The Fort Site is located inside the Pittsburgh city limits in Allegheny County, Pennsylvania. It was constructed in the hills of Pittsburgh's North Side to provide the final link for both legs of the relay triangle entering and leaving the Pittsburgh terminal. The Fort Site relay was located only 2.2 miles north of the Pittsburgh terminal in the Chamber of Commerce building located in the city's downtown. Western Union through the Telegraph Realty Company acquired three parcels comprising approximately 9 acres from Lon H. Grant in August 1945. In 1947 the property was transferred to the realty company's parent, the Western Union Telegraph Company. Western Union owned the property until 1970 when it was sold to the Federal Aviation Administration for $70,000.00.[115]

Western Union built a 100' tower at this relay site situated at 1,230' above mean sea level. In 1958 the City of Pittsburgh Housing Authority began acquiring property on which it completed a 999-unit housing project in 1962; the former Western Union site is located adjacent to this complex.

During its transition, likely in the 1950s, to second generation microwave equipment the tower likely was removed and replaced with what the company described as twin-masts of the "H type," essentially a pair of guyed lattice towers, outfitted with passive reflector or parabolic antennas.[116] In 2004 the site had the twin mast towers with parabolic antennas attached. The Western Union equipment building has been replaced by a two-story building at the base of the tower.

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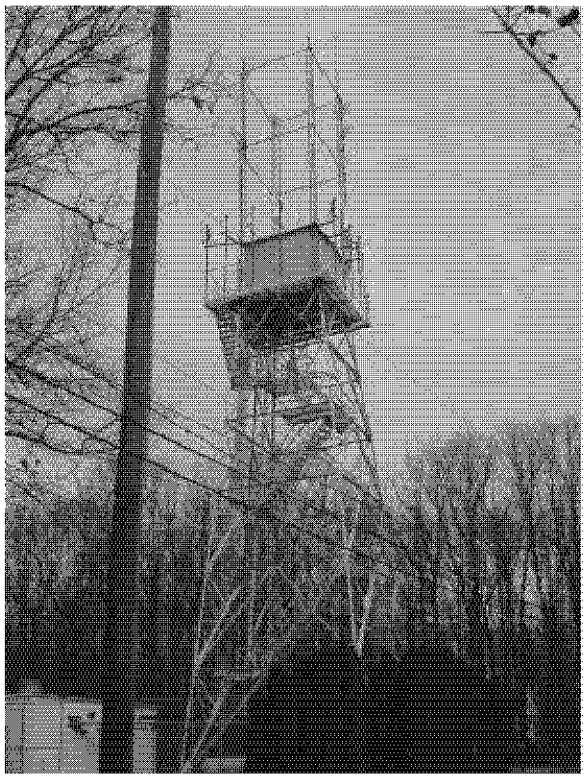
[115] Allegheny County Deed Book 2682, p. 69 (Grant to Telegraph Realty); Allegheny County Deed Book 2931, p. 557 (Telegraph Realty to Western Union)' Allegheny County Deed Book 8395, p. 146 (Western Union to the United States).

[116] Howe, "Engineering Progress 1945-1950."

Site Name: Honey Brook
Call Sign: KGB36
State: Pennsylvania
County: Chester
Municipality: West Cain Township
Address: Telegraph Road
Type of Facility: Relay
Original Tower Height: 60'



This relay site is located in West Cain Township, Chester County, Pennsylvania, in an area known as Baron Hills at an elevation of 955' above mean sea level. Western Union's subsidiary the Telegraph Realty Company acquired a 0.92 acre parcel from Martin and Mary Andes in October 1945. Two years later the parcel was transferred to the Realty Company's parent, the Western Union Telegraph Company. Western Union owned the property until July 1969 when it sold the relay site to Electro-Site, Inc. The following year Electro-Site changed its name to Edgemont Electronics. In 1974 Chester County seized the property for back taxes owed and the County sold it to Charles Hazzard who then sold it to Garden Spot Leasing Company in 1979. Triangle Communications in 1985 then purchased the property and it remains the property owner.[117]

Western Union constructed a 60' tower at this relay site. The tower, cab, and equipment building were at the site and in service by Triangle Communications. Alterations to the tower include the addition of whip antennas, cellular/PCS panel antenna arrays, and extender masts raising the tower's height above the cab level.

[117] Chester County Deed Book N-22, p. 64 (Andes to Telegraph Realty); Chester County Deed Book G-22, p. 453 (Telegraph Realty to Western Union); Chester County Deed Book B-39, p. 598 (Western Union to Electro-Site); Chester County Deed Book X-44, p. 260 (Chester County to Hazzard); Chester County Deed Book D-56, p. 253 (Hazzard to Garden Spot Leasing); Chester County Deed Book 46, p. 196 (Garden Spot Leasing to Triangle Communications).

Site Name: Mt. Holly
Call Sign: KGB38
State: Pennsylvania
County: Cumberland
Municipality: Dickinson Township
Address: Ridge Road (Tower Road)
Type of Facility: Relay
Original Tower Height: 60'

This relay site is located at an elevation of 1,463' above mean sea level in Dickinson Township, Cumberland County, Pennsylvania. Western Union's Telegraph Realty Company bought a 1-acre parcel along with a right-of-way linking the new relay site with Ridge Road from Millicent Kitzmiller for $1,000.00. The realty company transferred title to Western Union in 1947, which retained the property until 1967 when Television and Electronics Service Corporation bought it for $10,000.00. In 1999, Television and Electronics Service Corporation – by then trading as Waymaker Company – sold the site to Pennsylvania Microwave Network, Inc., the property's current owner.[118]

Western Union built a 60' tower at this relay site. The tower, cab, and equipment building were intact and still in service by the current owner in 2004. Alterations to the tower include the addition of parabolic and whip antennas plus a mast extending the overall height above the cab stage.

[118] Cumberland County Deed Book 13-B, p. 296 (Kitzmiller to Telegraph Realty); Cumberland County Deed Book 13-S, p. 281 (Telegraph Realty to Western Union); Cumberland County Deed Book22-P, p. 101 (Western Union to Television and Electronics Service Corp.); Cumberland County Record Book 213, p. 710 (Waymaker to Pennsylvania Micro-Wave Network).

Site Name: Red Lion
Call Sign: KGB37
State: Pennsylvania
County: York
Municipality: Windsor Township
Address: Indian Springs Road
Type of Facility: Relay
Original Tower Height: 100'

The Red Lion relay site is located in Windsor Township, York County, Pennsylvania, north of the town of Red Lion. The site is at an elevation of 995' above mean sea level on a parcel east of Pennsylvania State Route 24. The Telegraph Realty Company in September 1945 paid $725.00 to John and Melinda Ludwig for the lot and a perpetual right to cross the Ludwig property for access to the facility. Two years later the realty company transferred title to its parent, the Western Union Telegraph Company. Western Union in 1967 sold it to the Television and Electronics Service Corporation for $10,000.00. In 1999, Television and Electronics Service Corporation – by then trading as Waymaker Company – sold the site to Pennsylvania Microwave Network, Inc., the property's current owner.[119]

Western Union built a 100' tower at this relay site. Located in what was in 2004 the rear yard area of a single-family residence, the tower, cab, and equipment building were intact. Alterations to the tower include the mounting of parabolic and whip antennas plus a mast extending the overall height above the cab stage.

[119] York County Deed Book 31-L, p. 196 (Ludwigs to Telegraph Realty); York County Deed Book 32-W, p. 537 (Telegraph Realty to Western Union); York County Deed Book60-T, p. 505 (Western Union to Television and Electronics Service Corp.); York County Record Book 1386, p. 5408 (Waymaker to Pennsylvania Micro-Wave Network).

APPENDIX C: HISTORICAL PHOTOGRAPHS

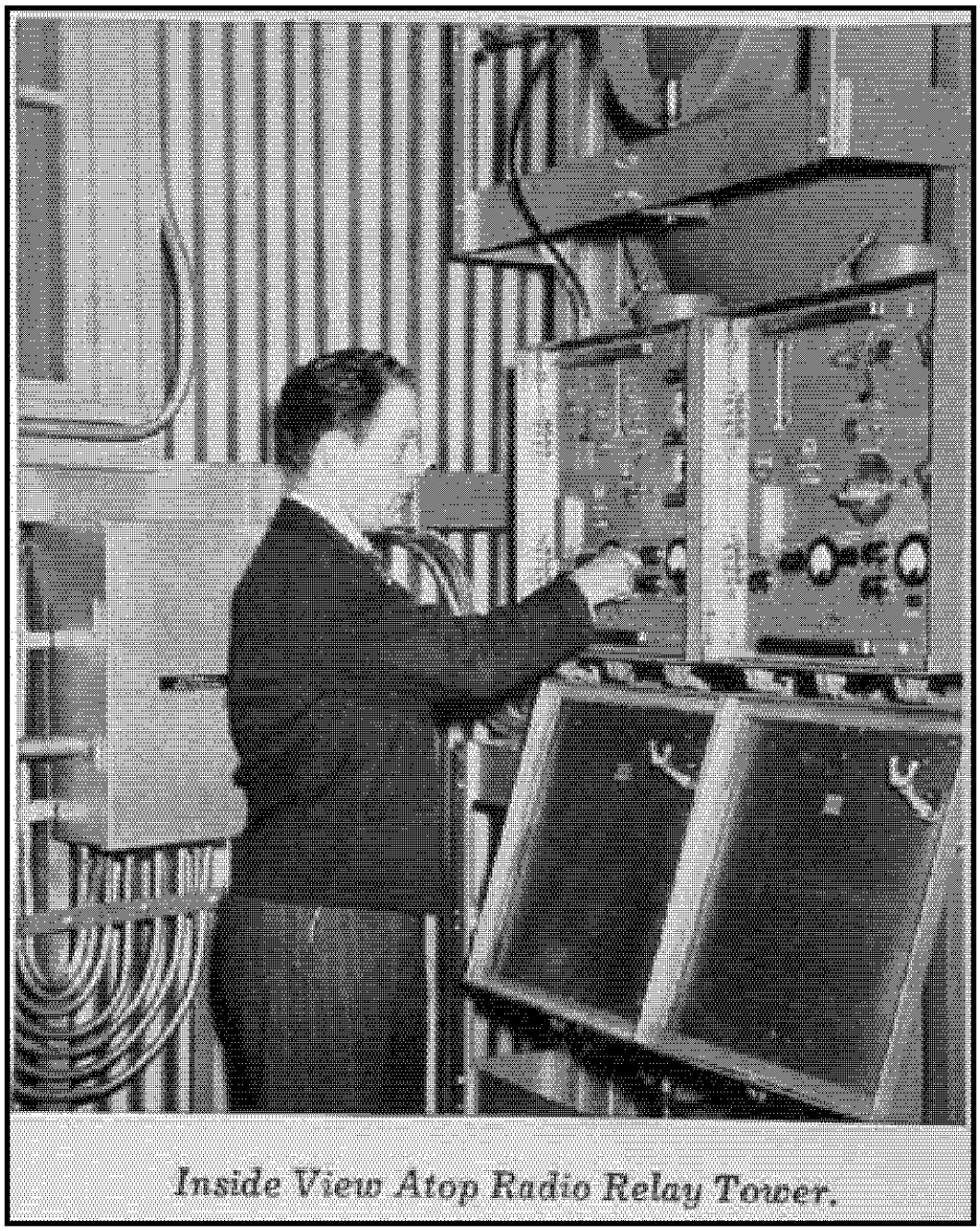


Figure 1. Photograph from the *Western Union Telegraph Company Annual Report*, 1948. Western Union Collection, Archives Center, National Museum of American History, Smithsonian Institution.

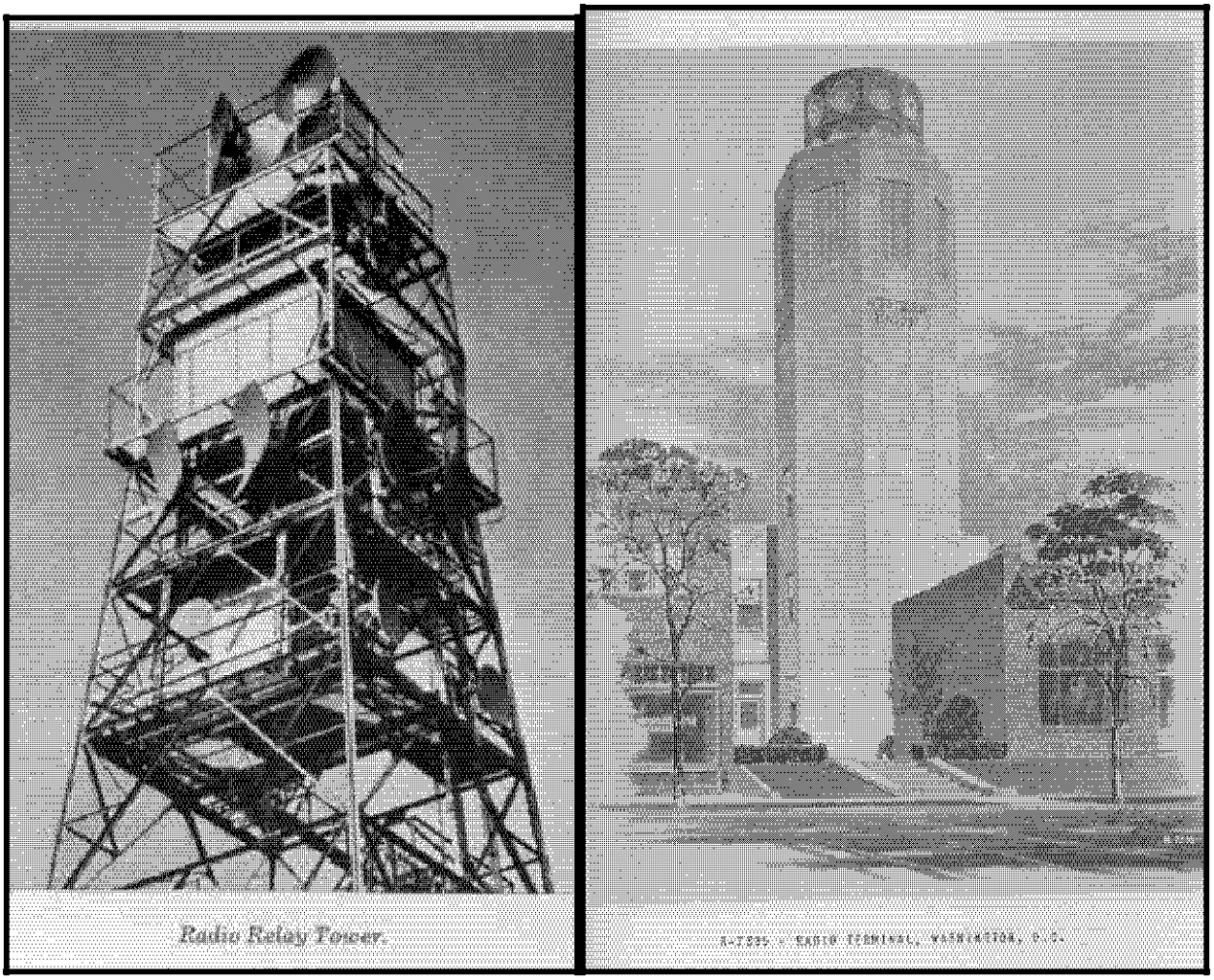


Figure 2. Photograph from the *Western Union Telegraph Company Annual Report*, 1948. Western Union Collection, Archives Center, National Museum of American History, Smithsonian Institution.

Figure 3. Architectural drawing of the Tenley terminal site in Washington, D.C. Western Union Collection, Archives Center, National Museum of American History, Smithsonian Institution.

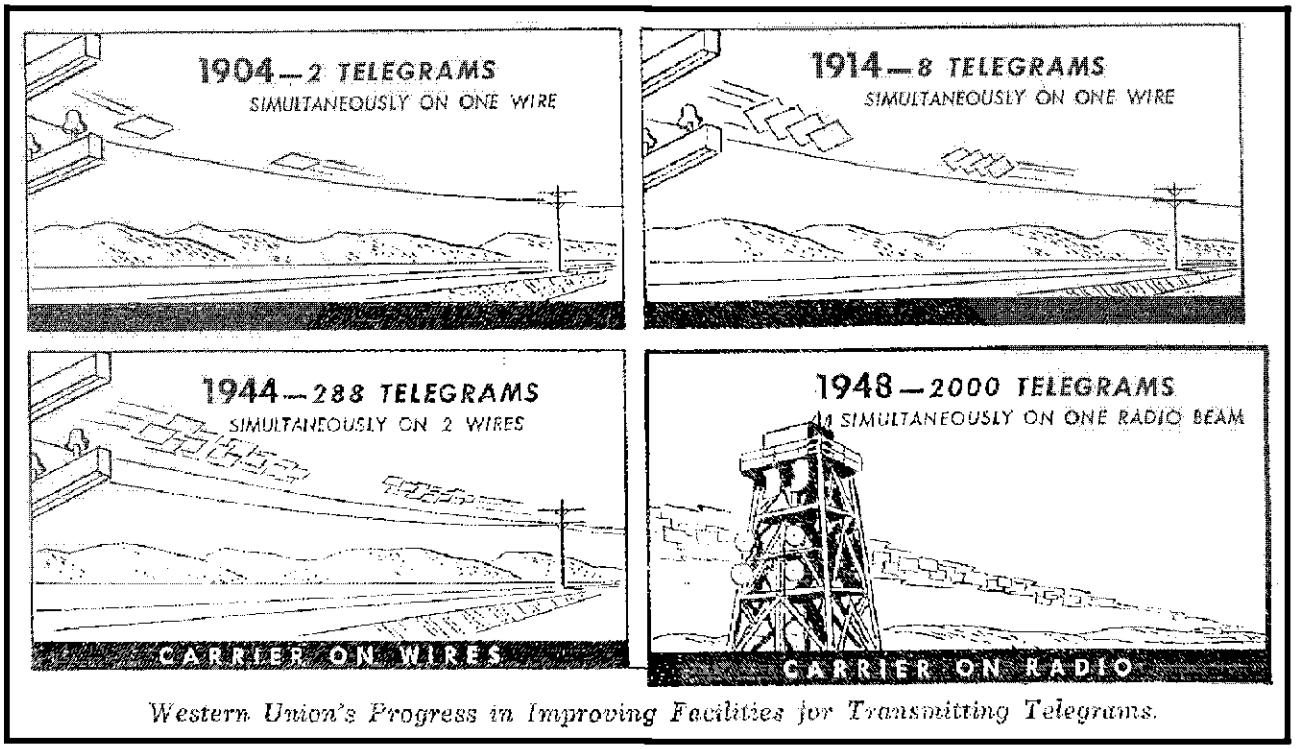


Figure 4. Western Union advertisement for new microwave network reprinted the *Western Union Telegraph Company Annual Report*, 1948. Western Union Collection, Archives Center, National Museum of American History, Smithsonian Institution.

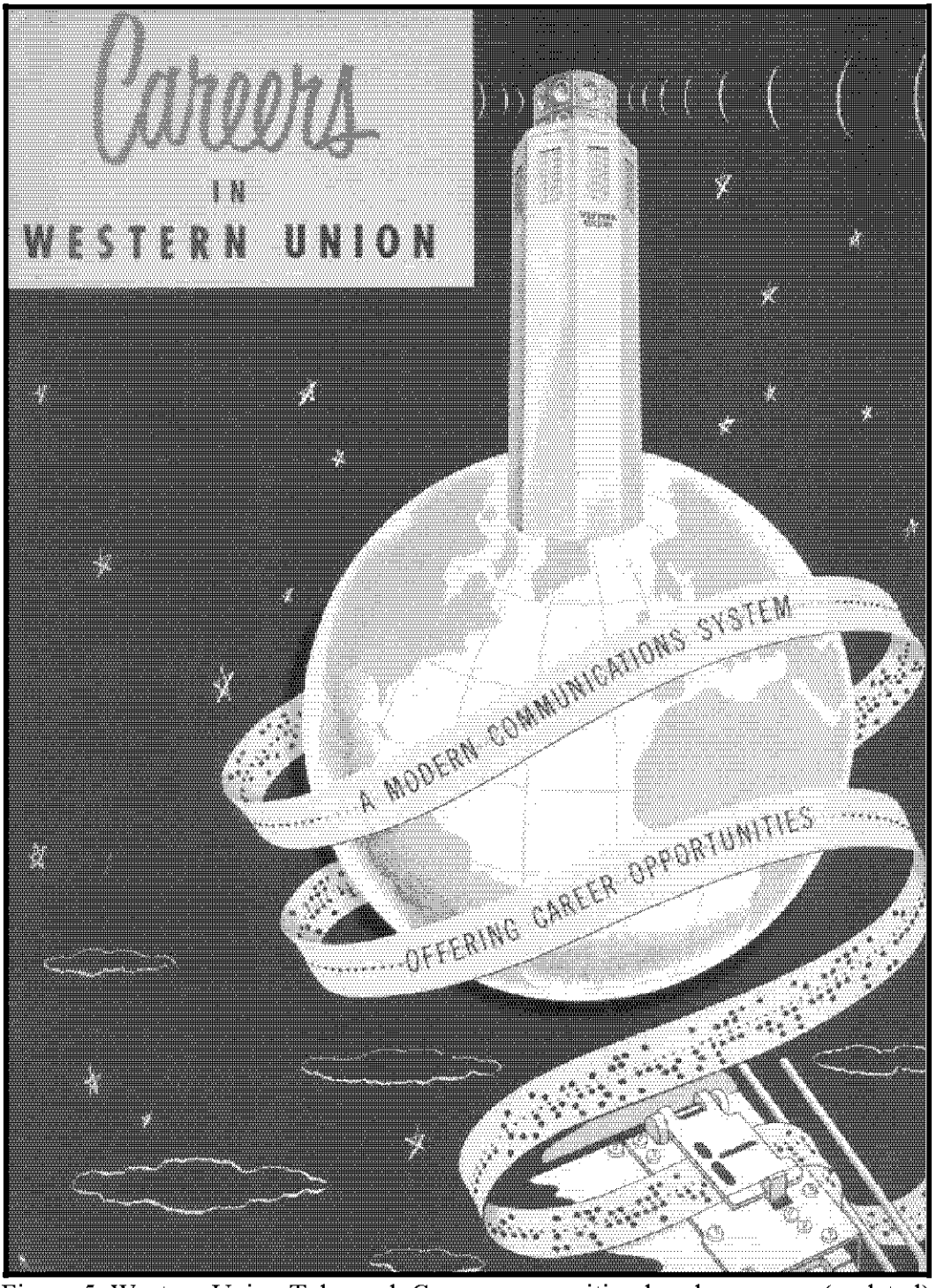


Figure 5. Western Union Telegraph Company recruiting brochure cover (undated). Note Tenley Terminal tower atop globe.

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New Castle Recorder of Deeds, Wilmington, Delaware
Anne Arundel County Clerk of Courts, Annapolis, Maryland
Frederick County Clerk of Courts, Frederick, Maryland
Washington County Clerk of the Circuit Court, Hagerstown, Maryland
Garrett County Clerk of Courts, Oakland, Maryland
Baltimore County Clerk, Towson, Maryland
Cecil County Clerk, Elkton, Maryland
Somerset County Clerk, Somerville, New Jersey
Burlington County Clerk, Mount Holly, New Jersey
Middlesex County Clerk, New Brunswick, New Jersey
Somerset County Recorder of Deeds, Somerset, Pennsylvania
Franklin County Recorder of Deeds, Chambersburg, Pennsylvania
Allegheny County Recorder of Deeds, Pittsburgh, Pennsylvania
Chester County Recorder of Deeds, West Chester, Pennsylvania
Cumberland County Recorder of Deeds, Carlisle, Pennsylvania
York County Recorder of Deeds, York, Pennsylvania
Bucks County Recorder of Deeds, Doylestown, Pennsylvania

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